

UNCLASSIFIED

AD NUMBER

AD368416

CLASSIFICATION CHANGES

TO: unclassified

FROM: confidential

LIMITATION CHANGES

TO:

Approved for public release, distribution
unlimited

FROM:

Distribution: DoD only: others to
Director, Naval Research Lab., Washington,
D. C.

AUTHORITY

Aug 1972, Group-4, DoDD 5200.10; NRL ltr,
26 Feb 2001.

THIS PAGE IS UNCLASSIFIED

CONFIDENTIAL

NRL Memorandum Report 754

**SUMMARY OF NAVY STUDY PROGRAM
FOR
F4H-1 WEAPON SYSTEM**

[UNCLASSIFIED TITLE]

APPENDIX TO VOLUME XI

J. C. Ryon
C. M. Loughmiller
R. L. Lister
I. N. Bellavin
M. Schmookler

RADAR DIVISION

August 1960



U. S. NAVAL RESEARCH LABORATORY
Washington, D.C.

In addition to security requirements which apply to this document and must be met, each transmittal outside the Department of Defense must have prior approval of the Director, U.S. Naval Research Laboratory, Washington, D.C. 20390.

JAN 17 1966

CONFIDENTIAL

DOWNGRADED AT 3-YEAR INTERVALS
DECLASSIFIED AFTER 12 YEARS
DOD DIR 5200.10

Further distribution of this report, or of an abstract, or reproduction thereof may be made only with the approval of the Director, Naval Research Laboratory, Washington 25, D. C., or of the activity sponsoring the research reported therein, as appropriate.

CONFIDENTIAL

SUMMARY OF NAVY STUDY PROGRAM
FOR
F4H-1 WEAPON SYSTEM
(Unclassified Title)

(Appendix to NRL Memorandum Report 754)

VOLUME XI

J. C. Ryon
C. M. Loughmiller
R. L. Lister
I. N. Bellavin
M. Schmookler

AUGUST 1960

NAVY DEPARTMENT
NAVAL RESEARCH LABORATORY
RADAR DIVISION

CONFIDENTIAL

CONFIDENTIAL

TABLE OF CONTENTS

	Page
LIST OF FIGURES	2
INTRODUCTION	6
MISSILE DATA	6
Seeker Data	6
Aerodynamic Range Equations	6
Steering Error Equations	7
Allowable Launch Error	8
Missile Head Slaving	8
Missile Head-Aim Equations	9
Sequence of Launch Operations	9
Noise Effects	10
Seeker and Autopilot Loops	10
Aerodynamic Data	11
Missile Physical Characteristics	13
TABLE I	14
ACKNOWLEDGEMENTS	15
REFERENCES	16

CONFIDENTIAL

LIST OF FIGURES

- Figure 1. Sparrow III Seeker Lock-on Range - 90% Cumulative Probability.
- Figure 2. Parameters Used in the Range Interlock Computer.
- Figure 3. Sparrow III Radome Refraction Curve.
- Figure 4. Noise Power Density vs Range - B-47 Target.
- Figure 5a. Model F4H-1 Missile Trajectory Time History.
- Figure 5b. Model F4H-1 Missile Trajectory Time History.
- Figure 6a. Model F4H-1 Missile Trajectory Time History.
- Figure 6b. Model F4H-1 Missile Trajectory Time History.
- Figure 7a. Model F4H-1 Missile Trajectory Time History.
- Figure 7b. Model F4H-1 Missile Trajectory Time History.
- Figure 8a. Model F4H-1 Missile Trajectory Time History.
- Figure 8b. Model F4H-1 Missile Trajectory Time History.
- Figure 9. Sparrow III Autopilot and Seeker Block Diagram.
- Figure 10. Orientation of Angles and Coefficients.
- Figure 11. Sparrow III Zero-Lift Drag.
- Figure 12. Sparrow III Drag Due to Normal Force vs Mach Number for Various Wing Deflections - $\phi_n = 0^\circ$.
- Figure 13. Sparrow III Drag Due to Normal Force vs Mach Number for Various Wing Deflections - $\phi_n = 45^\circ$.
- Figure 14. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 0.8$.
- Figure 15. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 0.8$.
- Figure 16. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 1.0$.
- Figure 17. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 1.0$.

CONFIDENTIAL

LIST OF FIGURES (cont)

- Figure 18. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 1.3$.
Figure 19. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 1.3$.
Figure 20. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 1.6$.
Figure 21. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 1.6$.
Figure 22. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 2.05$.
Figure 23. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 2.05$.
Figure 24. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 2.58$.
Figure 25. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 2.58$.
Figure 26. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 3.06$.
Figure 27. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 3.06$.
Figure 28. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 3.48$.
Figure 29. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 3.48$.
Figure 30. Sparrow III Coefficient of Normal Force - $\phi = 0^\circ$, $M = 3.98$.
Figure 31. Sparrow III Coefficient of Normal Force - $\phi = 45^\circ$, $M = 3.98$.
Figure 32. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 0.8$.
Figure 33. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 0.8$.
Figure 34. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 1.0$.
Figure 35. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 1.0$.
Figure 36. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 1.3$.
Figure 37. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 1.3$.
Figure 38. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 1.6$.
Figure 39. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 1.60$.

CONFIDENTIAL

LIST OF FIGURES (cont)

- Figure 40. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 2.05$.
Figure 41. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 2.05$.
Figure 42. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 2.58$.
Figure 43. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 2.58$.
Figure 44. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 3.06$.
Figure 45. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 3.06$.
Figure 46. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 3.49$.
Figure 47. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 3.49$.
Figure 48. Sparrow III Pitching Moment Coefficient - $\phi = 0^\circ$, $M = 3.98$.
Figure 49. Sparrow III Pitching Moment Coefficient - $\phi = 45^\circ$, $M = 3.98$.
Figure 50. Sparrow III Estimated Pitch Derivatives - $Cm_{\dot{\phi}}$ vs M .
Figure 51. Sparrow III Estimated Pitch Derivatives - $Cm_{\dot{\phi}}$ vs M .
Figure 52. Sparrow III Estimated Rolling Moment Coefficient - $M = 0.5$.
Figure 53. Sparrow III Estimated Rolling Moment Coefficient - $M = 0.8$.
Figure 54. Sparrow III Estimated Rolling Moment Coefficient - $M = 0.87$.
Figure 55. Sparrow III Estimated Rolling Moment Coefficient - $M = 1.0$.
Figure 56. Sparrow III Estimated Rolling Moment Coefficient - $M = 1.1$.
Figure 57. Sparrow III Estimated Rolling Moment Coefficient - $M = 1.3$.
Figure 58. Sparrow III Estimated Rolling Moment Coefficient - $M = 1.5$.
Figure 59. Sparrow III Estimated Rolling Moment Coefficient - $M = 2.0$.
Figure 60. Sparrow III Estimated Rolling Moment Coefficient - $M = 2.5$.
Figure 61. Sparrow III Estimated Rolling Moment Coefficient - $M = 3.1$.

CONFIDENTIAL

LIST OF FIGURES (cont)

- Figure 62. Sparrow III Estimated Rolling Moment Coefficient - $M = 4.27$.
- Figure 63. Sparrow III Estimated Rolling Moment Coefficient Due to
Aileron Deflection.
- Figure 64. Sparrow III Estimated Roll Moment Damping Coefficient.
- Figure 65. Sparrow III Wing Aeroelastic Correction Factor.
- Figure 66. Sparrow III Tail Aeroelastic Correction Factor.
- Figure 67. Sparrow III Aerodynamic Center Aeroelastic Correction Factor.
- Figure 68. Sparrow III Typical Thrust/Time Curve.
- Figure 69. Sparrow III - Change of Thrust With Altitude.

CONFIDENTIAL

SUMMARY OF NAVY STUDY PROGRAM FOR F4H-1 WEAPON SYSTEM

INTRODUCTION

The study effort covered by this volume is primarily concerned with the investigation of the Sparrow III 6a launching and guidance phases. From such an investigation the effect of these phases on overall system probability of success can be determined. For this reason it was necessary to conduct an accurate and detailed simulation of the Sparrow III 6a missile. Through the excellent cooperation of the prime contractor, a detailed knowledge of this missile was gained. Examples of this cooperative effort are given in references 1 and 2. After conversion of the data obtained to simulation methods and techniques, the prime contractor reviewed the entire simulation program (reference 3).

MISSILE DATA

This appendix details the basic data used in the simulation of the Sparrow III 6a missile.

Seeker Data

Figure 1 shows the 90% probability of seeker lock-on against a B-47 size target for the missile studied. This is the result of NMC tests (reference 4) scaled to the B-47 size target. It is seen that the seeker has a 90% lock-on capability against the B-47 size target, head-on, of 6.82 n. mi.

Aerodynamic Range Equations

The AN/APA-128 computer equations used in the simulation are as follows:

$$R_{\max} = R_1(h) / T_1(V_c - V_f) \quad R_{\max} \leq 6.5 \text{ n. mi.} \quad (1)$$

$R_{\max}$ = maximum launch range

$R_1(h)$ varies with altitude as shown on Fig. 2

V_c = closing velocity

V_f = fighter velocity

$T_1 = 11$ secs for $V_c > V_f$

T_1 varies with altitude for $V_c < V_f$ as shown on Fig. 2

CONFIDENTIAL

$$R_{\min} = R_2 (h) + T_2 V_c \quad (2)$$

$R_{\min}$ = minimum launch range

$R_2 (h)$ varies with altitude as shown on Fig. 2

$T_2 = 4.3 \text{ sec}$

$$R_{su} = R_{\max} + T_3 V_c - R_3 \quad (3)$$

R_{su} = Pull-up range

$T_3 = 10 \text{ sec}$

$R_3 = 6000 \text{ ft}$

Steering Error Equations

$$V_o = 800 \left[1 + 0.41 (1 - P/P_{SL}) \right] \quad (4)$$

$V_o = V_{ma} - V_f$

V_{ma} = average missile velocity

P = pressure at altitude

P_{SL} = pressure at sea level

$$\epsilon_a = \frac{57.3 V_o \sin \lambda_a + R \frac{\omega_k}{1+S}}{2300} \quad (5)$$

ϵ_a = azimuth steering error in degrees

λ_a = azimuth gimbal angle

R = range in feet

ω_k = azimuth line of sight rate in radian/sec

$$\epsilon_e = \frac{57.3 \left[-V_o \sin \lambda_e \cos \lambda_a \right] + R \frac{\omega_j}{1+S} - 0.48^\circ I}{2300} \quad (6)$$

ϵ_e = elevation steering error in degrees

CONFIDENTIAL

λ_e = elevation gimbal angle

ω_j = elevation line of sight rate in radians/sec

α_I = angle of attack (angle between aircraft
RGMA and velocity vector)

Allowable Launch Error

$$E = \lambda + K_3 \frac{R}{R_{\max}} \left| V_c - K_1 V_f \right| - K_2 \left| V_c - K_1 V_f \right| \quad (7)$$

E = allowable launch error in degrees

$$\lambda = 3^\circ$$

$$K_1 = 0.75$$

$$K_2 = 0.0054 \text{ deg/ft/sec}$$

$$K_3 = 0.015 \text{ deg/ft/sec}$$

$R_{\max}$ = maximum aerodynamic range (not limited to 6.5 n. mi.)

Missile Head Slaving

$$IEB_e = + (\lambda_e - E_e) \quad (8)$$

$$IEB_a = + (\lambda_a - E_a) \quad (9)$$

IEB_e = initial English Bias in elevation

IEB_a = initial English Bias in azimuth

In the F4H-1 (Sparrow III 6a) system, the missiles will be rolled 45° .

The effect of this roll must be accounted for in the English Bias. Thus

$$FEB_e = 0.707 IEB_e + 0.707 IEB_a \quad (10)$$

$$FEB_a = 0.707 IEB_e + 0.707 IEB_a \quad (11)$$

FEB_e = final English Bias in elevation

FEB_a = final English Bias in azimuth

CONFIDENTIAL

The initial English bias and the final English bias are then combined into a composite signal to be applied to the yaw and pitch channels of the autopilot. The equations for these composite English bias signals are:

$$-EB_p = (IEB_e - FEB_e)e^{-t} + FEB_e \quad (12)$$

$$-EB_y = (IEB_a - FEB_a)e^{-t} + FEB_a \quad (13)$$

EB_p = composite English Bias signal applied to the pitch channel

EB_y = composite English Bias signal applied to the yaw channel

Missile Head-Aim Equations

$$\lambda_{ami} = \tan^{-1} \left\{ \frac{\cos a [\sin \lambda_a (\cos \lambda_e - \dot{\lambda}_1 \sin \lambda_e) + \dot{\lambda}_a \cos \lambda_a] + \sin a [\sin \lambda_e + \dot{\lambda}_1 \cos \lambda_e]}{\cos \lambda_a (\cos \lambda_e - \dot{\lambda}_1 \sin \lambda_e) - \dot{\lambda}_a \sin \lambda_a} \right\} \quad (14)$$

λ_{ami} = missile azimuth gimbal angle at launch

$\left. \begin{array}{l} \dot{\lambda}_1 = \omega_j \\ \dot{\lambda}_2 = \omega_k \end{array} \right\}$ filtered with $\frac{1}{1+s}$ type filter

a = stored missile roll angle with respect to the interceptor

$$\lambda_{emi} = \tan^{-1} \left\{ \frac{\cos \lambda_{ami} \{ \cos a (\sin \lambda_e + \dot{\lambda}_1 \cos \lambda_e) - \sin a [\sin \lambda_a (\cos \lambda_e - \dot{\lambda}_1 \sin \lambda_e) + \dot{\lambda}_2 \cos \lambda_a] \}}{\cos \lambda_a (\cos \lambda_e - \dot{\lambda}_1 \sin \lambda_e) - \dot{\lambda}_2 \sin \lambda_a} \right\} \quad (15)$$

λ_{emi} = missile elevation gimbal angle at launch

Sequence of Launch Operations

There are several time delays between missile commitment and seeker lock-on time. It is important to inject these time delays into the overall simulation. The sequence of events occurring at launch are:

1. Missile commitment zero time
2. From missile commitment to start of ejection stroke (Umbilical is pulled at start of ejection stroke) 1.01 seconds

CONFIDENTIAL

3. Motor ignition	1.08 seconds
4. End of stroke	1.09 seconds
5. Thrust applied	1.23 seconds
6. Wing unlock	1.41 seconds
7. End of thrust	3.23 seconds
8. Seeker lock-on	$\left\{ \begin{array}{l} 2.32 \text{ seconds for} \\ R_{\min} \text{ launch} \\ 3.23 \text{ seconds for} \\ R_{\max} \text{ launch} \end{array} \right.$

Noise Effects

There are several noise effects which must be considered in the simulation of the launching and guiding of the Sparrow III missile. The first of these is the noise due to radome refraction in the Sparrow III seeker. The radome refraction curve used was obtained from Raytheon and is shown by Fig. 3.

The next noise effect which was considered is that due to the target. The noise power density versus range for the Sparrow III missile against a B-47 size target is shown on Fig. 4 (reference 5).

The final noise effect that was simulated is that due to transients occurring during missile launch. These transients are due to the fact that the missile is launched into a high velocity airstream. The resulting transient effects are given by Figs. 5a thru 8b. This data was obtained from McDonnell Aircraft Co. (reference 6).

Seeker and Autopilot Loops

The block diagrams of the seeker and autopilot are shown by Fig. 9. The gains and the time constants are given on Table I. The definitions of the additional symbols used are as follows:

ω_{j_m} = antenna elevation angular rate with respect to inertial space

ω_{K_m} = antenna azimuth angular rate with respect to inertial space

CONFIDENTIAL

$n_{c(p)}$ = normal acceleration commanded in pitch
 $n_{c(y)}$ = normal acceleration commanded in yaw
 n_z = normal acceleration measured along the missile Z axis
 n_y = normal acceleration measured along the missile Y' axis
 p, q, r = components of missile angular velocity about the body axes x, y' and z' respectively
 K = autopilot gain
 τ = autopilot time constant
 δ_p = angular deflection of pitch wings
 δ_y = angular deflection of yaw wings
 δ_a = differential angular deflection of pitch wings
 $\bar{R}$ = Range
 $\dot{R}_{FT}$ = range rate, fighter-to-target
 $\dot{R}_{FM}$ = range rate, fighter-to-missile
 $\dot{R}_{MT}$ = range rate, missile-to-target
 IC = initial conditions

Aerodynamic Data

The orientations of various angles and coefficients pertaining to the aerodynamic data are shown on Fig. 10. The actual aerodynamic data (reference 7) used in the simulator are shown on Fig. 11 thru 67. A brief description of each type of data along with the appropriate figure numbers are as follows:

1. C_{D0} = Zero-lift drag coefficient - C_{D0} for all altitudes is given for the boost and the glide conditions as a function of Mach in Fig. 11. The change in coefficient of drag due to normal force is given by Figs. 12 and 13.

CONFIDENTIAL

2. C_N = Coefficient of normal force C_N , corrected for aero-elastic effects, is given as a function of Mach, wing deflection, angle of attack and roll angle on Figs. 14 thru 31.
3. C_m = Pitching moment coefficient C_m , corrected for aero-elastic effects, is given as a function of Mach, wing deflection, angle of attack and roll angle on Figs. 32 thru 49.
4. $C_{m\dot{\delta}}$ & $C_{m\dot{\alpha}}$ = Estimated pitch derivatives $C_{m\dot{\delta}}$ and $C_{m\dot{\alpha}}$ are given on Figs. 50 and 51.
5. C_{ℓ} = Estimated roll moment coefficient C_{ℓ} is given as a function of Mach, angle of attack and roll angle for differential wing deflection of 6° on Figs. 52 thru 62. For angle of attack and wing deflection both equal to zero, the roll moment coefficient $C_{\ell\delta_a}$ is given on Fig. 63 as a function of Mach. Roll moment coefficient versus angle of attack for $\delta_a = 0^\circ$ is not currently available and will be assumed to be zero.
6. $C_{\ell p}$ = Estimated roll clamping moment coefficient. $C_{\ell p}$ is given as a function of Mach number on Fig. 64.
7. Aeroelastic correction factors are given for the wings, tail and aerodynamic center on Figs. 65, 66, 67.

CONFIDENTIAL

8. The thrust vs time curves of Fig. 68 were approximated by assuming a thrust (at sea level) of 7300 lbs. acting for an interval of two seconds. The thrust correction for altitude is obtained from Fig. 69.

Missile Physical Characteristics

These characteristics are for the C8 motor without short autopilot.

Weight before launch = 399.8 lbs.

Weight after burnout = 328.8 lbs.

Center of gravity before launch = Sta. 82.01" + 0.5" - 1.0"

Center of gravity after burnout = Sta. 75.01" + 0.5" - 1.0"

Wing area (S) = 1.265 ft² per panel - 2.53 ft² total

Tail area = 0.77 ft² each panel

Wing span ($\bar{b}$) = 3.3 ft

Wing chord ($\bar{c}$) = 1.106 ft

Mechanical wing limits = $\pm 22^\circ$

Electrical wing limits = $\pm 20^\circ$

Antenna mechanical gimbal limits = $\pm 50^\circ$

Antenna electrical gimbal limits = $\pm 46^\circ$

Moment of Inertial:

I_{xx} = 1.45 slug-ft² at launch, 1.31 slug-ft² at burnout

I_{yy} = 103 slug-ft² at launch, 79.7 slug-ft² at burnout

I_{zz} = 103 slug-ft² at launch, 79.9 slug-ft² at burnout

CONFIDENTIAL

TABLE I

SPARROW III AUTOPILOT PARAMETERS

$t \triangleq$ TIME FROM LAUNCH (TIME FROM END OF STROKE)

$t_1 \triangleq$ UNLOCK TIME = (0.4-0.08) SEC

$t_2 \triangleq$ END-OF-BOOST TIME = (2.22-0.08) SEC

$t_3 \triangleq$ MISSILE SEEKER LOCK-ON TIME = (2.22-0.08) SEC

ALTITUDE CONDITION	A	B	C	D
ALTITUDE	SL-17K	17-32K	32-46	>46K
τ_s (SEC)	.15 0.085	.15 0.085	0.4 0.129	0.4 0.129
τ_s YAW (SEC) PITCH	4.93 3.87	3.17 2.49	1.70 1.33	1.09 .857
K_s (o/g SEC)	3.57	5.56	10.5	16.3
τ_b (SEC)	0.0053	0.0063	0.008	0.008
G_2 (o/o/SEC)	$\frac{1.14}{1+25S}$	$\frac{1.14}{1+12.5S}$	$\frac{3.43}{1+25S}$	$\frac{3.43}{1+12.5S}$
K_g o/o/SEC.	0.054	0.110	0.21	0.43

CONFIDENTIAL

ACKNOWLEDGEMENTS

The data presented in this report is that collected and used in the missile simulation phase of the Navy's Air-to-Air Missile Study Program. It was supplied to NRL directly by the Raytheon Company from personnel at the Bedford Laboratory who also checked the manner in which it was used in the simulation on the IBM 704 computer. The Technical Directors (NRL) of the study program wish to thank the personnel of the Bedford Laboratory for their assistance in this vital phase of the Navy's effort. Computer services and the bulk of work necessary to convert the raw data into a well coordinated simulation of the missile was performed by the Analytical Section of the Westinghouse Air Arm Division. The Technical Directors would also like to thank these people for the role they played in obtaining meaningful results for the Navy's arsenal of knowledge.

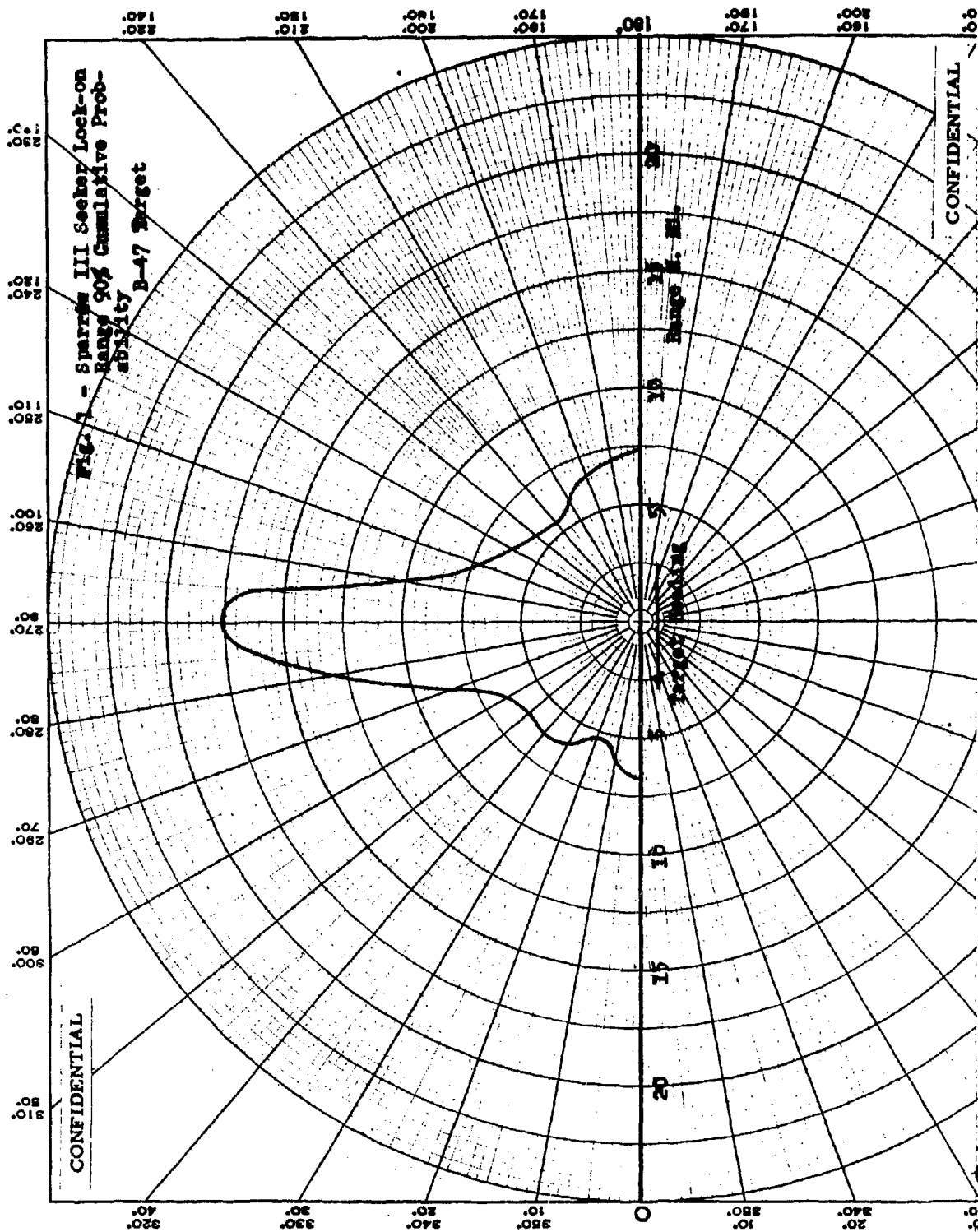
This report was prepared by the following members of the Systems Section, Equipment Research Branch.

J. C. Ryon
C. M. Loughmiller
M. Schmookler
R. L. Lister
I. N. Bellavin

CONFIDENTIAL

REFERENCES

1. NRL RCS 5367-428, 25 July 1958, Confidential, "Obtain Aerodynamic Data on Sparrow III and Discuss Navy Study of Sparrow III From Arrival at Firing Point to Impact."
2. NRL RCS 5367-691, 11 December 1958, Confidential, "Discuss Input Data Describing the Sparrow III 6a Missile to be used in the Navy's Air-to-Air Missile Study."
3. NRL RCS, 18 March 1959, Confidential, "Discuss the Method of Simulation of the Sparrow III on the IBM 704 Computer and the Results Obtained to Date."
4. "Comparison of Project V and Sparrow III Seekers," (Preliminary) Project TED MTC GM-3410, NAMTC, Secret.
5. Noise Power Density Curves based on calculations made by D. Howard, NRL.
6. MAC Missile Transient Data.
7. "Excerpts from Sparrow III Data Manual, "Raytheon, Confidential, 1 July 1958.



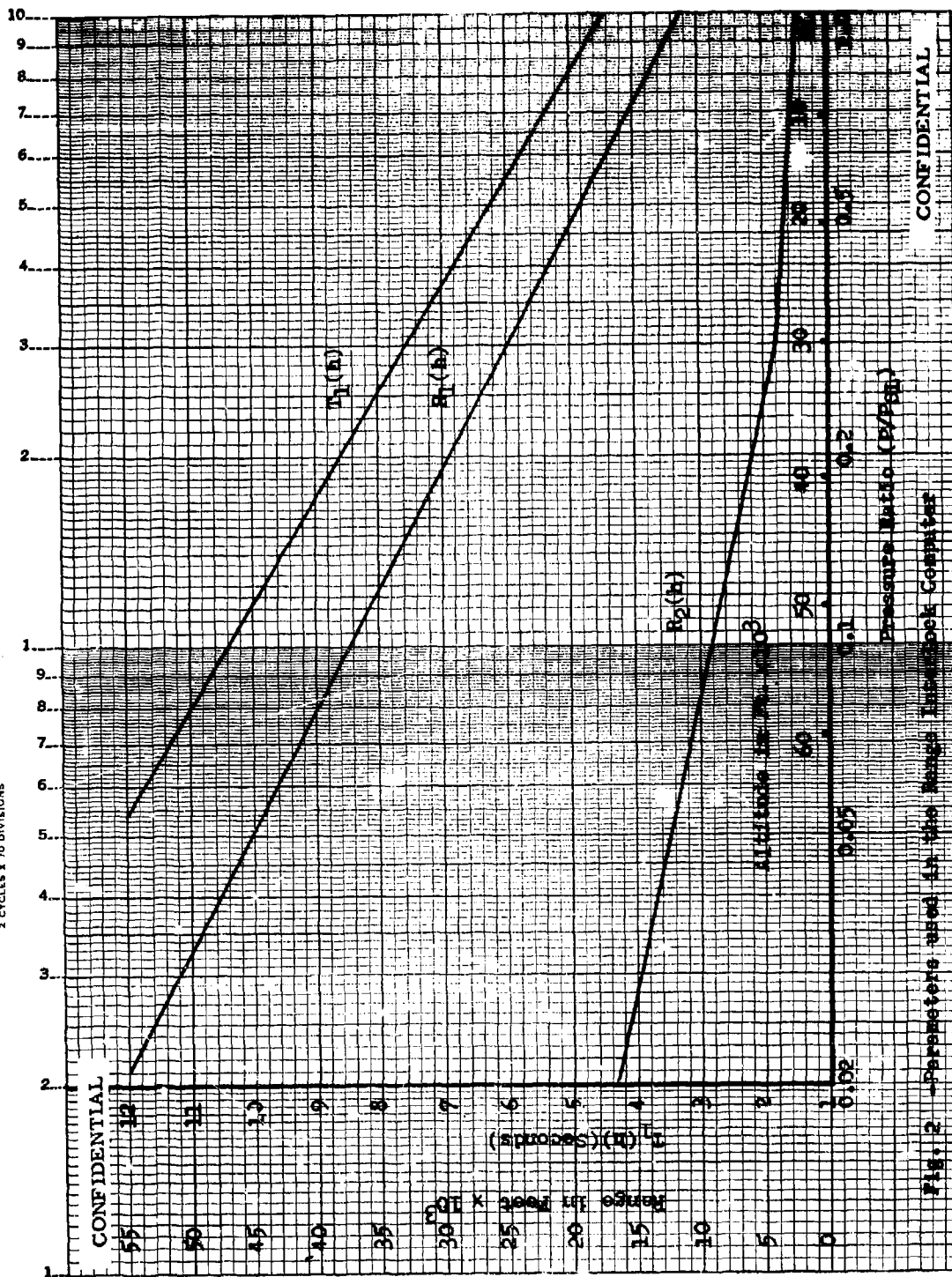
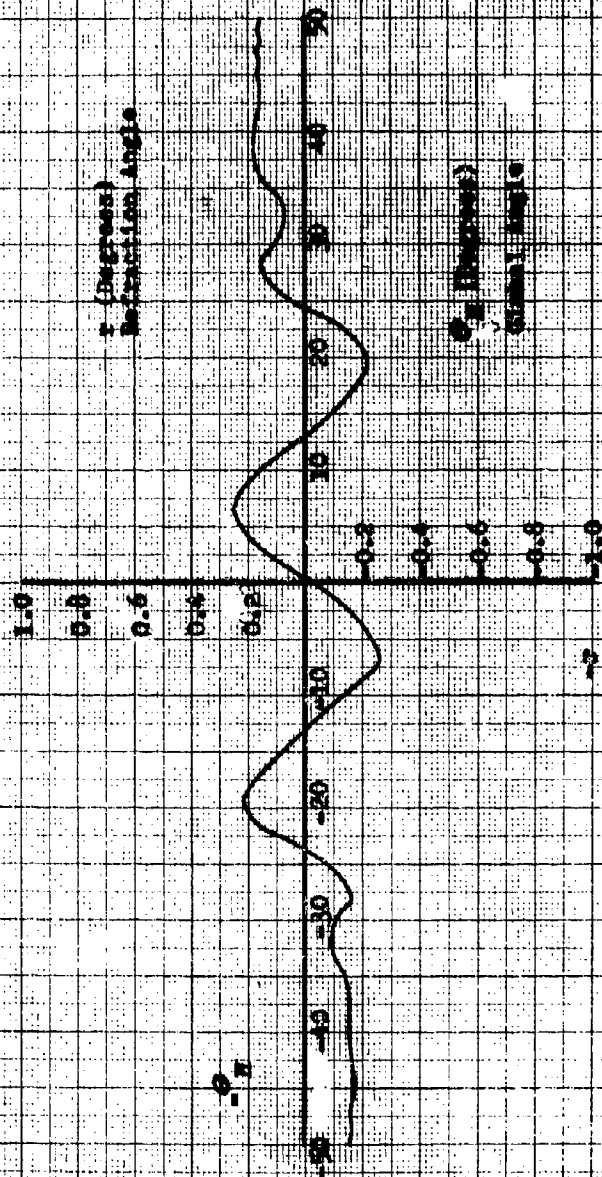


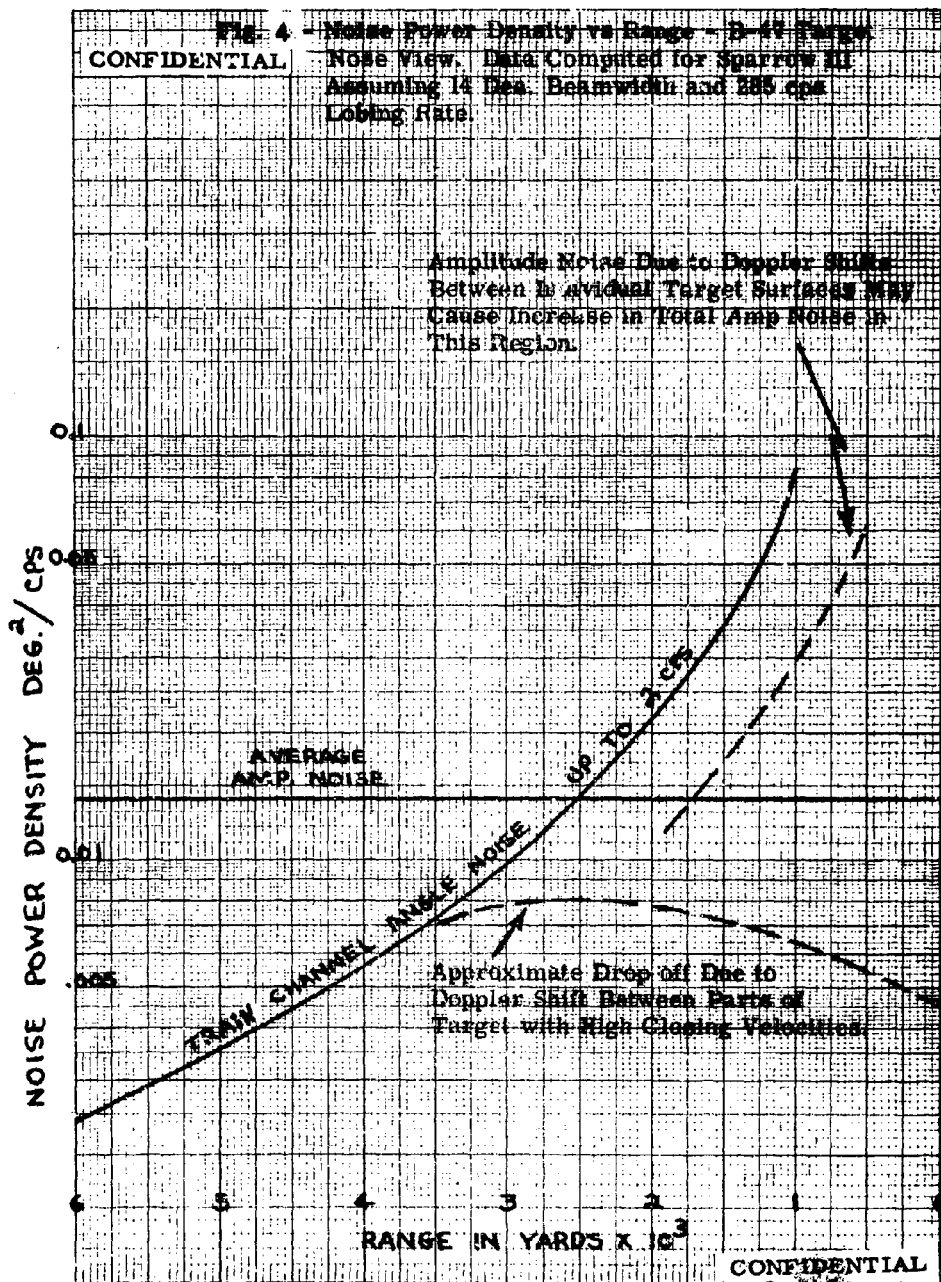
FIG. 3 - SPECTRUM FOR REFLECTION CURVE

CONFIDENTIAL

$$-0.048 \leq R \leq 0.058$$



CONFIDENTIAL



CONFIDENTIAL Fig. 5a - MODEL F4H-1 MISSILE TRAJECTORY TIME HISTORY LEFT - HAND AFT MISSILE

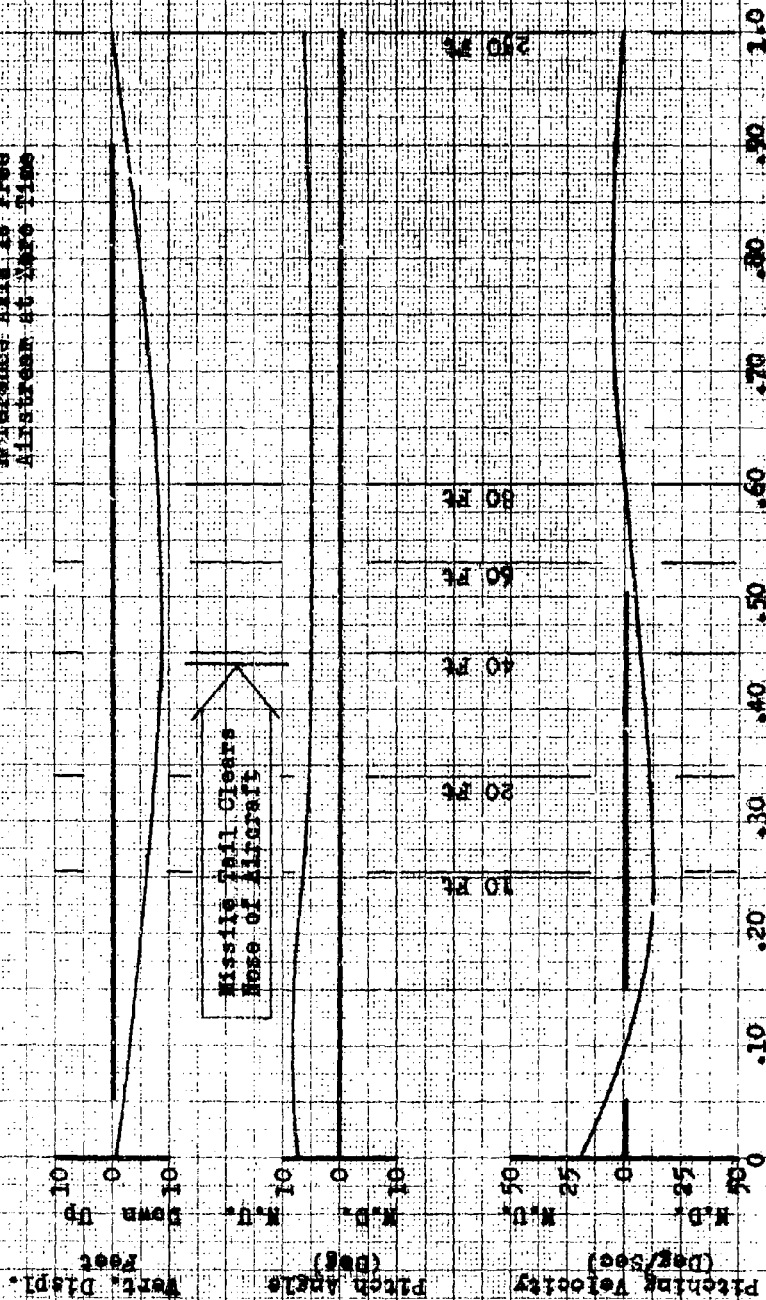
Initial Conditions

- 1 - Ejector Type Launch
- 2 - Controls Locked
- 3 - Mach Number = 0.80
- 4 - $H_p = 45,000$ Ft
- 5 - $M_z = 1g$
- 6 - $\dot{\theta}_d = 0.312$ Rad/Sec

- 7 - $\dot{\gamma}_0 = 0$ Rad/Sec
- 8 - $\dot{\theta}_0 = 0$ Deg
- 9 - Ignition at $t = 0.1$ Sec
- 10 - Ejection Impulse = $14.5 g's$ (Max)
- 11 - Rocket Thrust = 6875 lbs (Net) (7-DAYE)

Note:

Reference Axis is Free
Airstream at Zero Time



Elapsed Time - Seconds

CONFIDENTIAL

CONFIDENTIAL

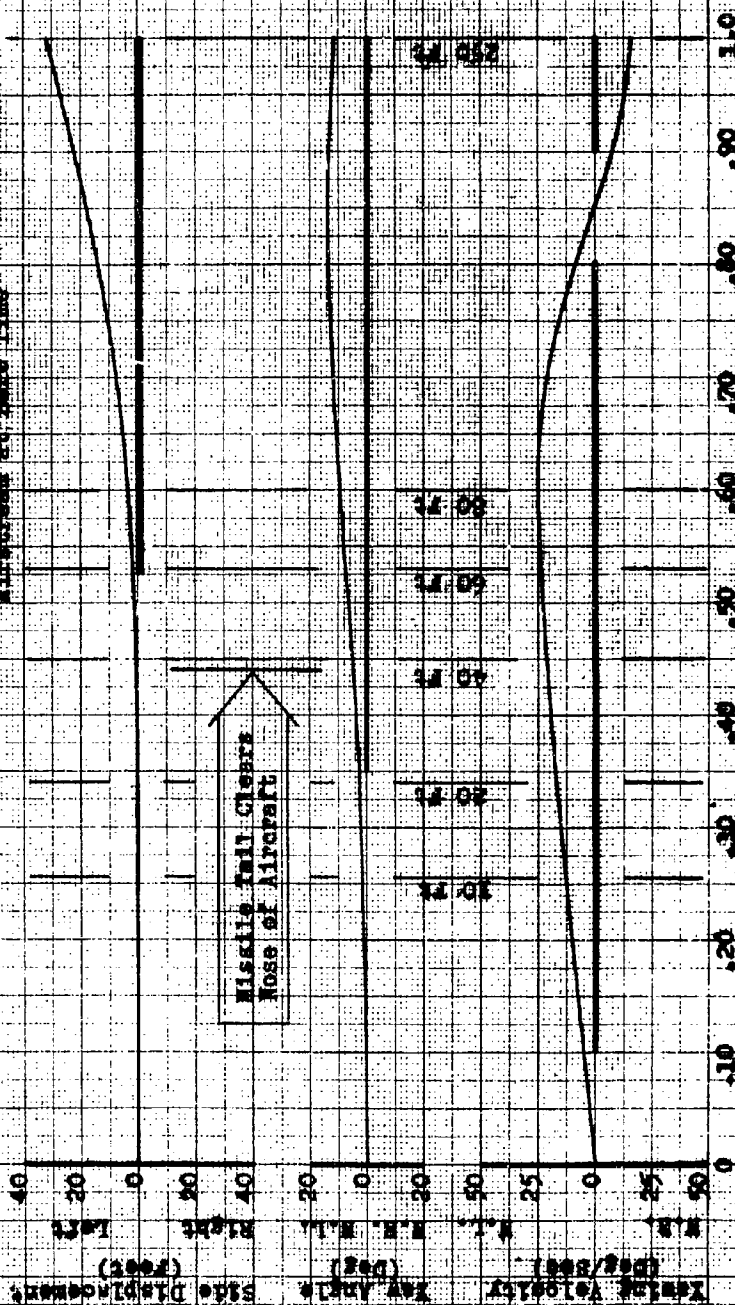
Fig. 50 - MODEL 70-1 GUIDANCE SYSTEMS WITH HIGH-ALTITUDE MISSILE - 1000 YARD MISSILE

Initial Conditions

- 1 - Rocket Type Launch
- 2 - $V_0 = 0$ Rad/Sec
- 3 - Controls Locked
- 4 - $\theta = 0$ Deg
- 5 - Back Number = 0.80
- 6 - $\theta = 0$ Deg
- 7 - Ignition at $T = 0.1$ Sec
- 8 - Rocket Number = 10
- 9 - Rocket Number = 10
- 10 - Rocket Number = 10
- 11 - Rocket Number = 10
- 12 - Rocket Number = 10
- 13 - Rocket Number = 10
- 14 - Rocket Number = 10
- 15 - Rocket Number = 10
- 16 - Rocket Number = 10
- 17 - Rocket Number = 10
- 18 - Rocket Number = 10
- 19 - Rocket Number = 10
- 20 - Rocket Number = 10
- 21 - Rocket Number = 10
- 22 - Rocket Number = 10
- 23 - Rocket Number = 10
- 24 - Rocket Number = 10
- 25 - Rocket Number = 10
- 26 - Rocket Number = 10
- 27 - Rocket Number = 10
- 28 - Rocket Number = 10
- 29 - Rocket Number = 10
- 30 - Rocket Number = 10
- 31 - Rocket Number = 10
- 32 - Rocket Number = 10
- 33 - Rocket Number = 10
- 34 - Rocket Number = 10
- 35 - Rocket Number = 10
- 36 - Rocket Number = 10
- 37 - Rocket Number = 10
- 38 - Rocket Number = 10
- 39 - Rocket Number = 10
- 40 - Rocket Number = 10
- 41 - Rocket Number = 10
- 42 - Rocket Number = 10
- 43 - Rocket Number = 10
- 44 - Rocket Number = 10
- 45 - Rocket Number = 10
- 46 - Rocket Number = 10
- 47 - Rocket Number = 10
- 48 - Rocket Number = 10
- 49 - Rocket Number = 10
- 50 - Rocket Number = 10
- 51 - Rocket Number = 10
- 52 - Rocket Number = 10
- 53 - Rocket Number = 10
- 54 - Rocket Number = 10
- 55 - Rocket Number = 10
- 56 - Rocket Number = 10
- 57 - Rocket Number = 10
- 58 - Rocket Number = 10
- 59 - Rocket Number = 10
- 60 - Rocket Number = 10
- 61 - Rocket Number = 10
- 62 - Rocket Number = 10
- 63 - Rocket Number = 10
- 64 - Rocket Number = 10
- 65 - Rocket Number = 10
- 66 - Rocket Number = 10
- 67 - Rocket Number = 10
- 68 - Rocket Number = 10
- 69 - Rocket Number = 10
- 70 - Rocket Number = 10
- 71 - Rocket Number = 10
- 72 - Rocket Number = 10
- 73 - Rocket Number = 10
- 74 - Rocket Number = 10
- 75 - Rocket Number = 10
- 76 - Rocket Number = 10
- 77 - Rocket Number = 10
- 78 - Rocket Number = 10
- 79 - Rocket Number = 10
- 80 - Rocket Number = 10
- 81 - Rocket Number = 10
- 82 - Rocket Number = 10
- 83 - Rocket Number = 10
- 84 - Rocket Number = 10
- 85 - Rocket Number = 10
- 86 - Rocket Number = 10
- 87 - Rocket Number = 10
- 88 - Rocket Number = 10
- 89 - Rocket Number = 10
- 90 - Rocket Number = 10
- 91 - Rocket Number = 10
- 92 - Rocket Number = 10
- 93 - Rocket Number = 10
- 94 - Rocket Number = 10
- 95 - Rocket Number = 10
- 96 - Rocket Number = 10
- 97 - Rocket Number = 10
- 98 - Rocket Number = 10
- 99 - Rocket Number = 10
- 100 - Rocket Number = 10

Note

Reference Axis is Free
Airspeed at Zero Time

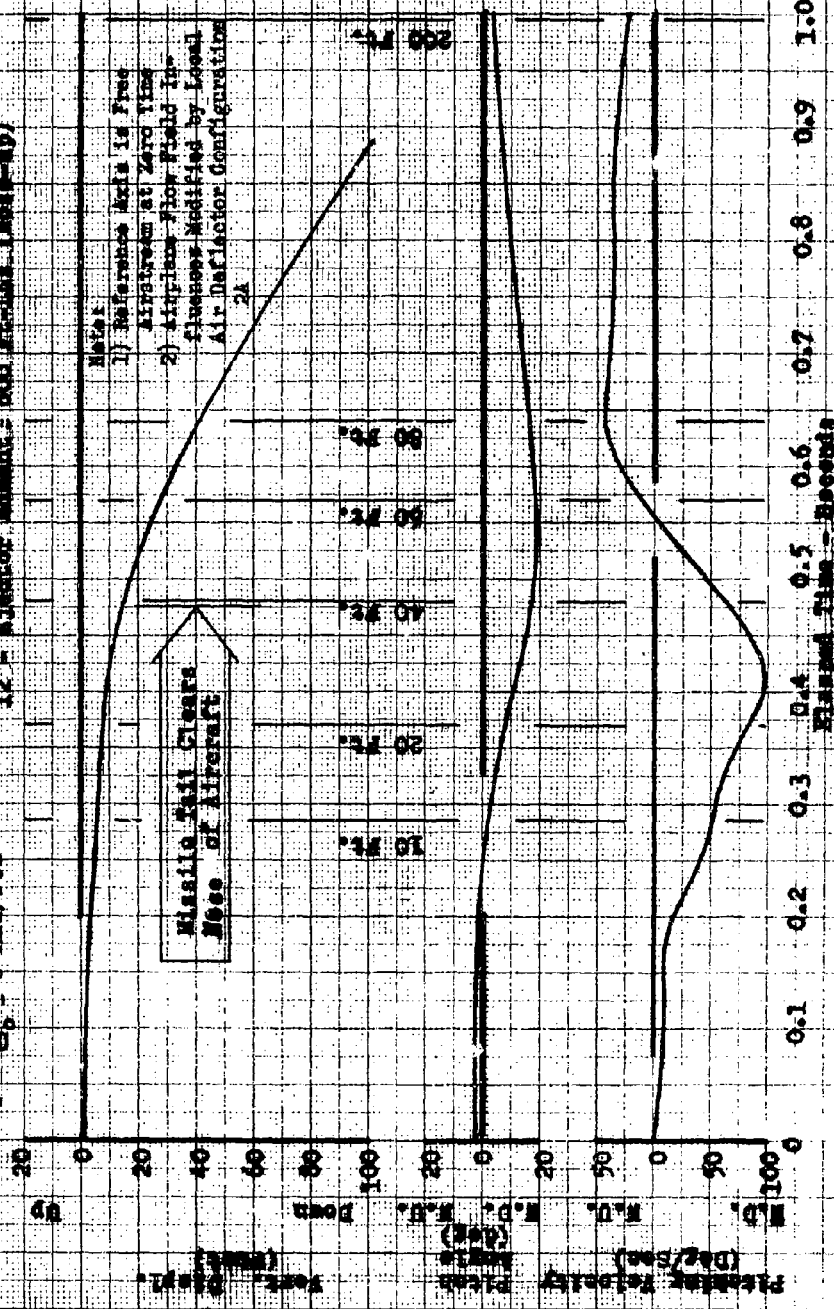


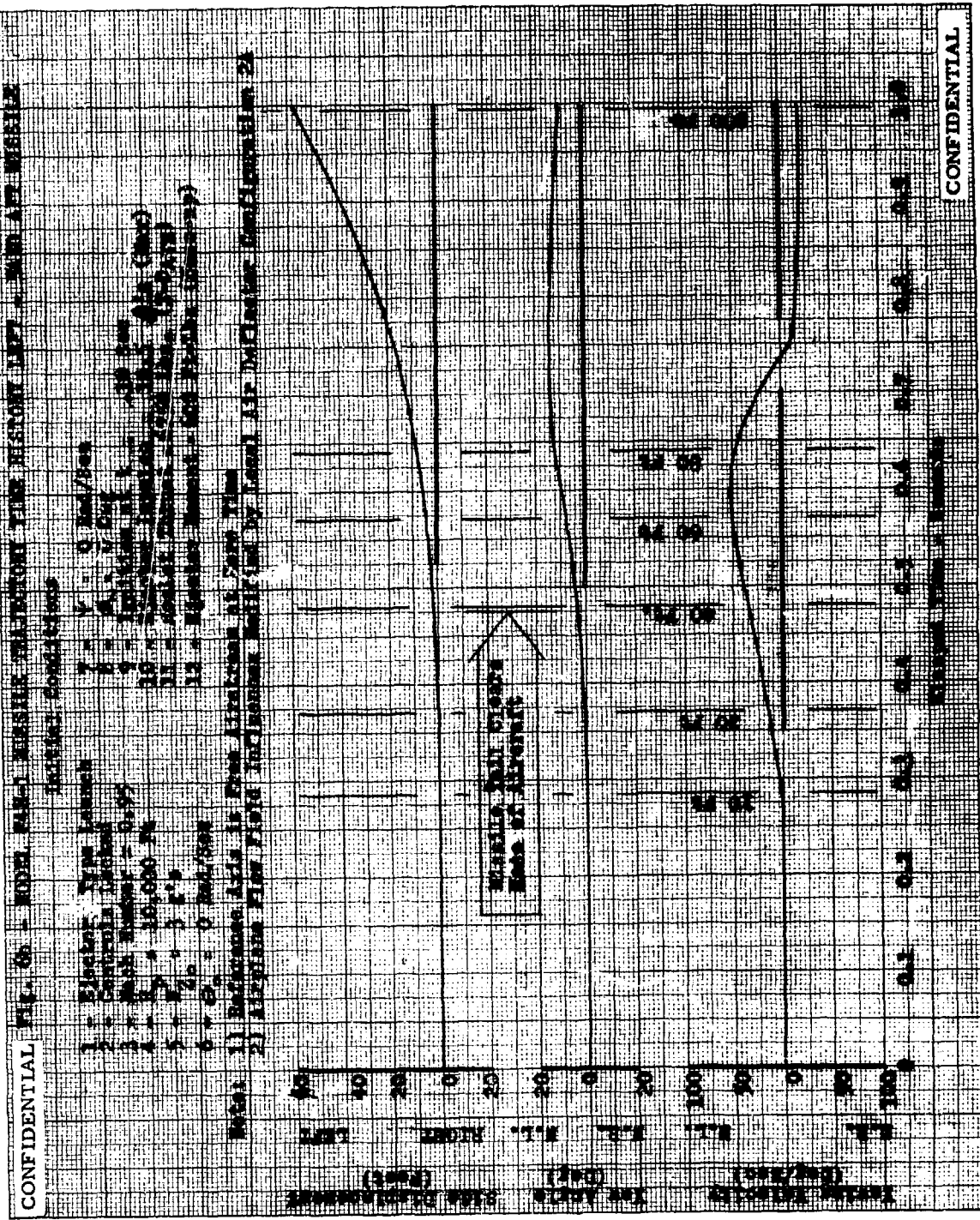
CONFIDENTIAL

CONFIDENTIAL Fig. 6A - MODEL F4M-1 MISSILE TRAJECTORY TIME HISTORY LEFT - HAND ANT MISSILE

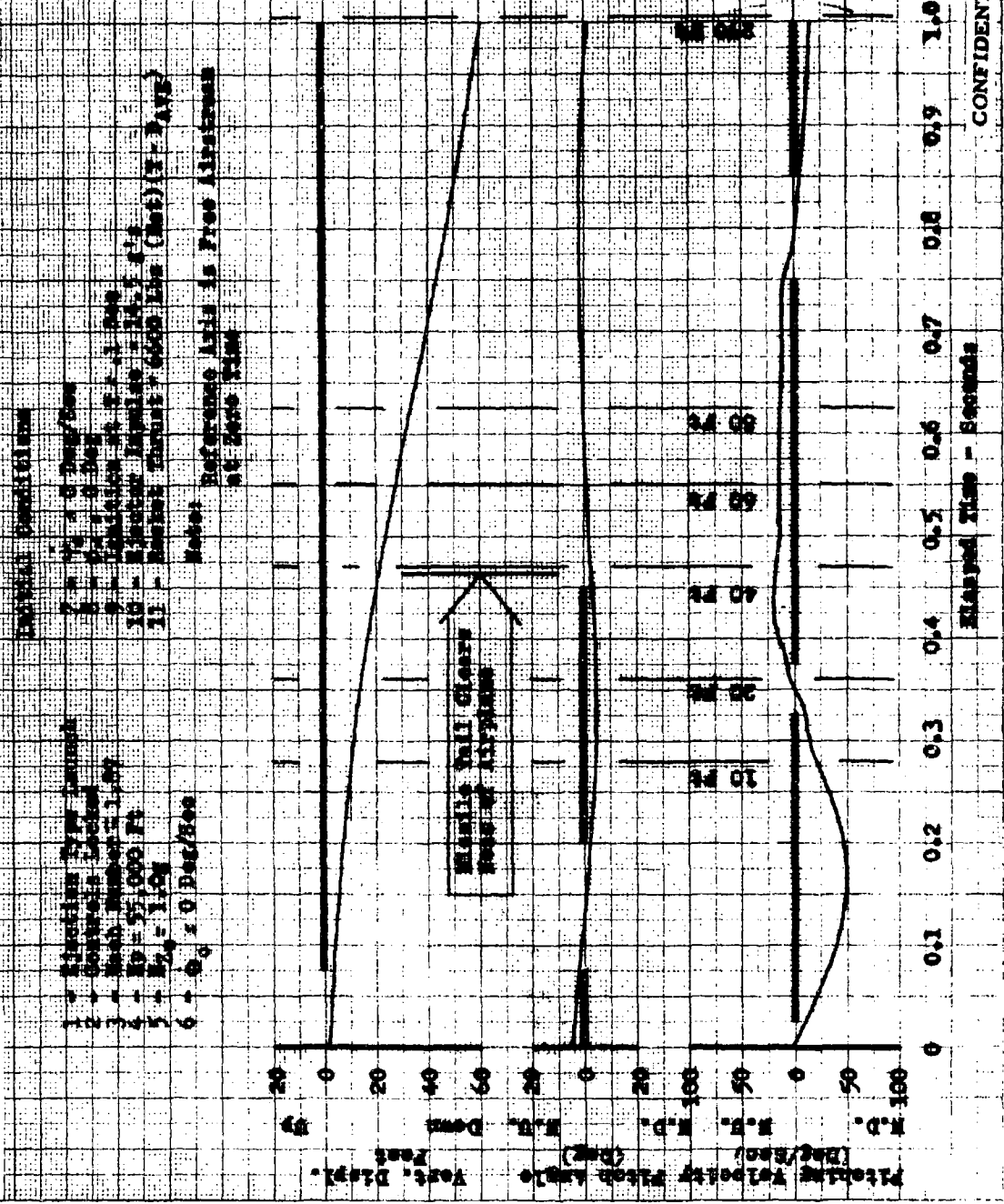
Initial Conditions

- | | |
|-----------------------------|---|
| 1 - Ejector Type Launch | 7 - $\dot{\gamma} = 0$ Rad/Sec |
| 2 - Controls Locked | 8 - $\dot{\alpha} = 0$ Deg |
| 3 - Mach Number = 0.95 | 9 - Ignition at $t = .10$ Sec |
| 4 - $H_0 = 10,000$ Ft | 10 - Ejector Pressure = 14.5 PSI (Gauge) |
| 5 - $\dot{H}_0 = 3$ Ft/Sec | 11 - Ejector Thrust = 6750 Lbs. (3-DAYE) |
| 6 - $\dot{C}_D = 0$ Rad/Sec | 12 - Ejector Moment = 600 Ft-Lbs (3-DAYE) |

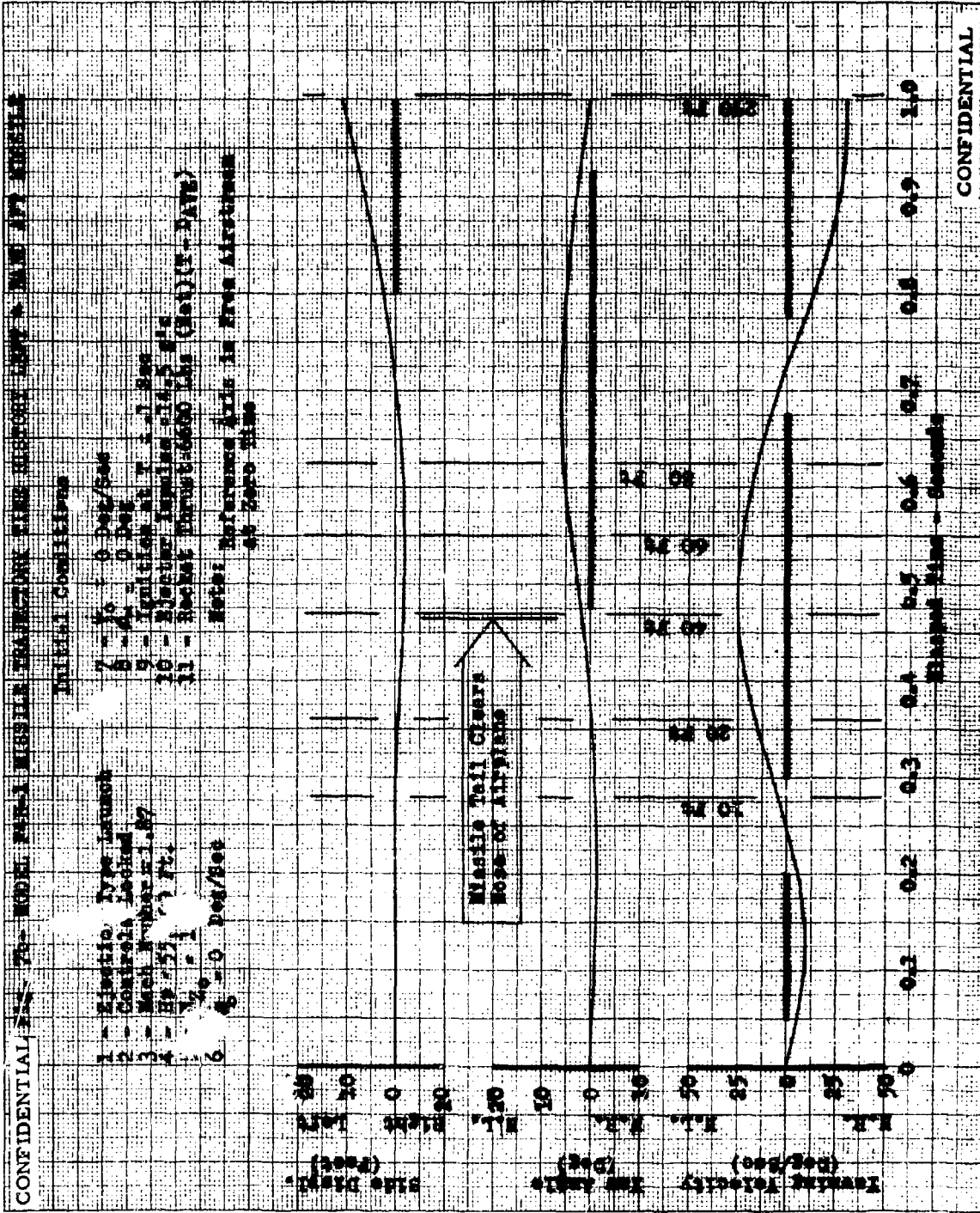


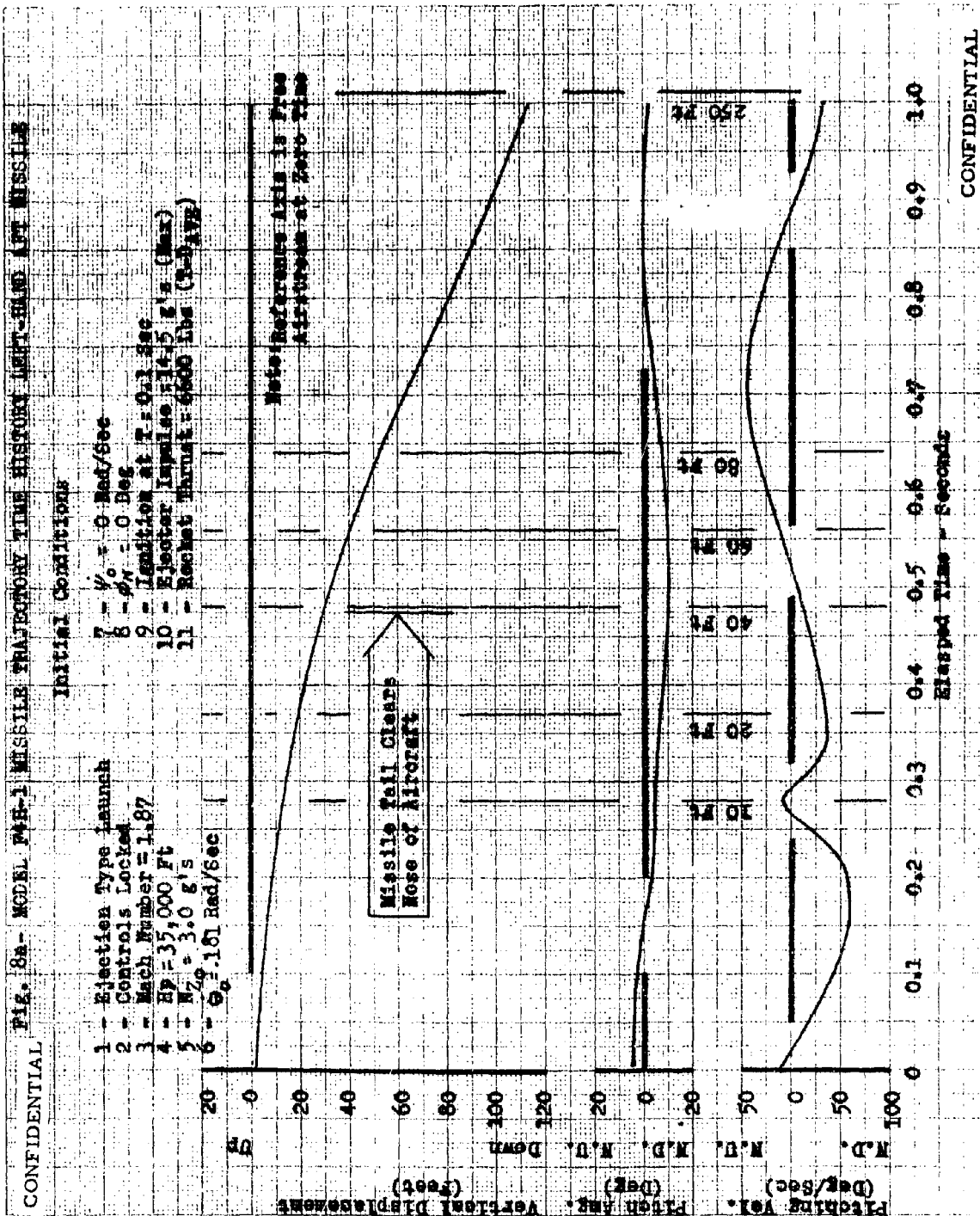


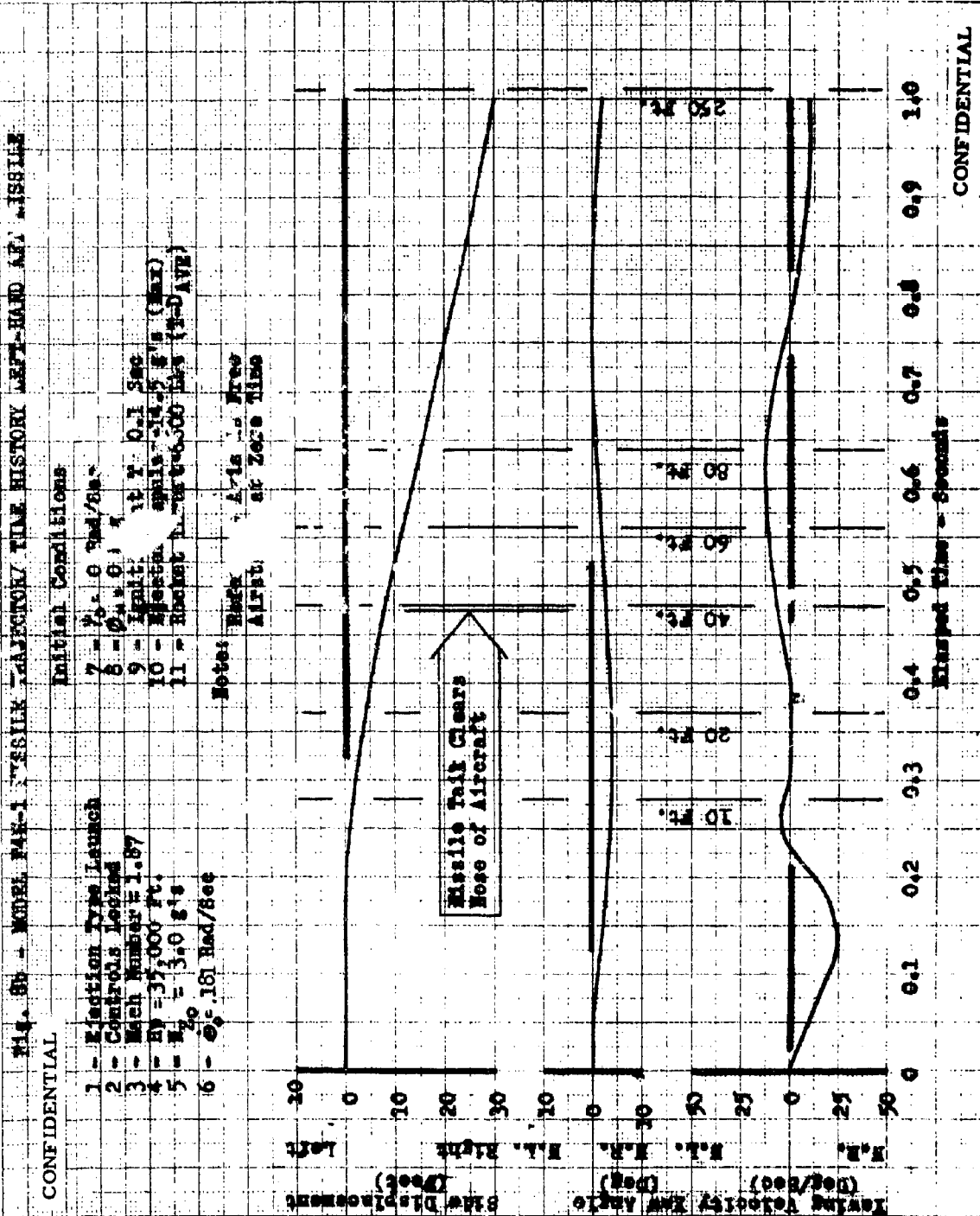
CONFIDENTIAL FIG. 7a- RKN-1 MISSILE PERFORMANCE TIME HISTORY PLOT - RND APT MICHIGAN



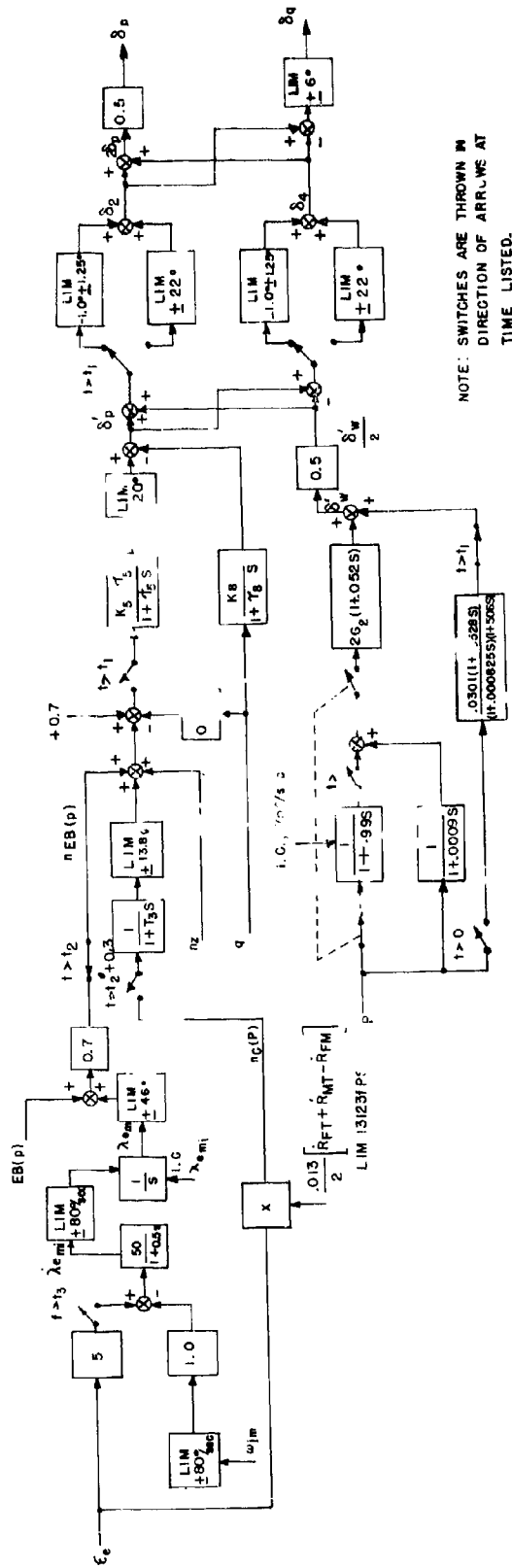
CONFIDENTIAL







CONFIDENTIAL



NOTE: SWITCHES ARE THROWN IN DIRECTION OF ARROWS AT TIME LISTED.

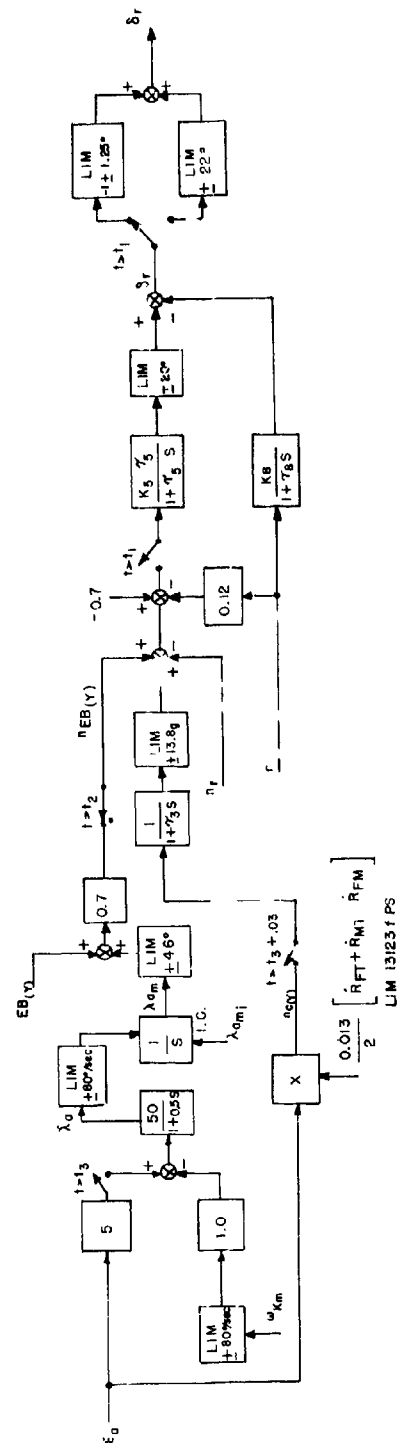


Fig. 9 - Sparrow III Autopilot and Seeker Block Diagram

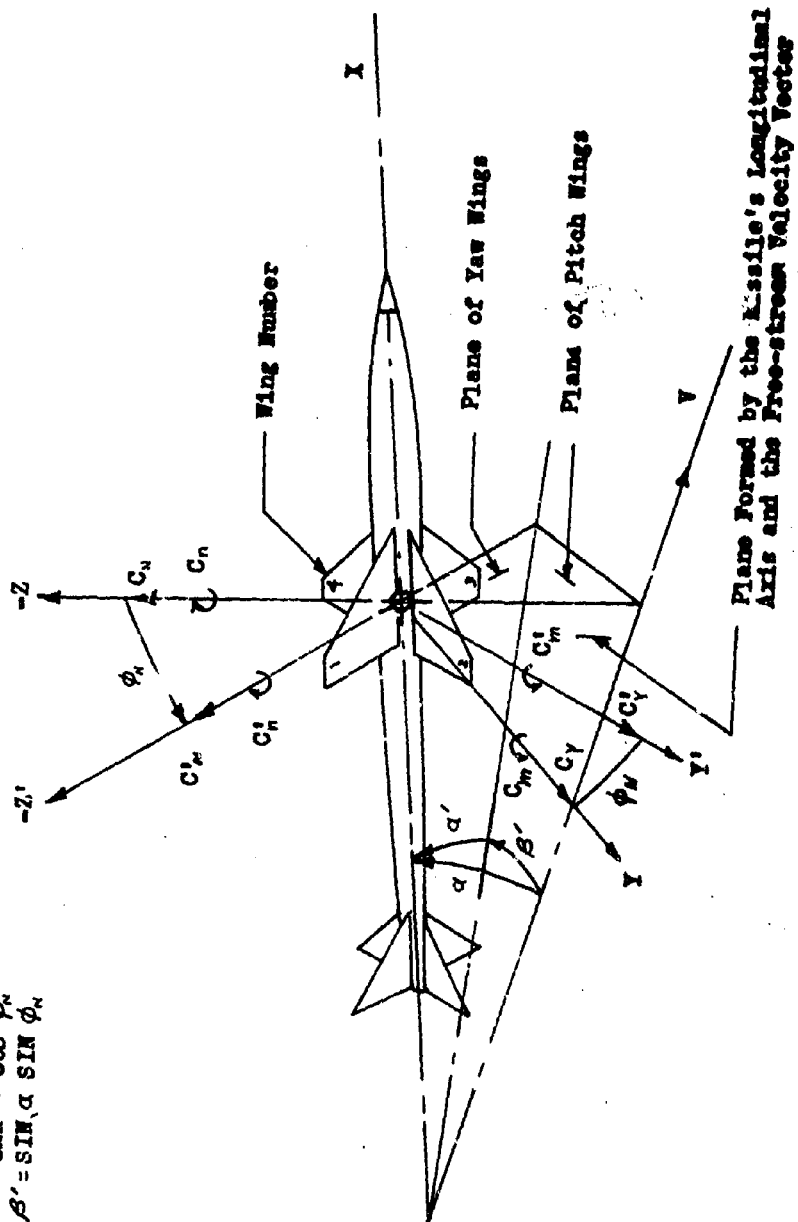
CONFIDENTIAL

CONFIDENTIAL

Fig. 10 - ORIENTATION OF ANGLES AND CO-EFFICIENTS

Note: Arrows indicate direction of positive quantities.

$$\begin{aligned} \tan \alpha' &= \tan \alpha \cos \phi_n \\ \sin \beta' &= \sin \alpha \sin \phi_n \end{aligned}$$

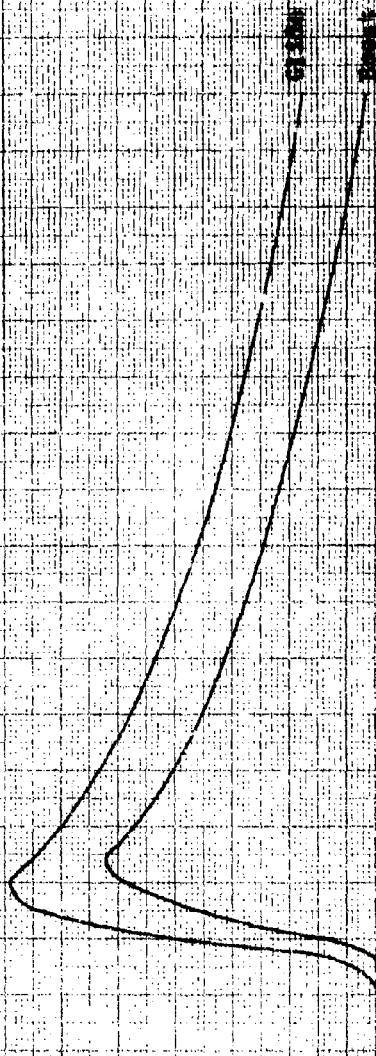


CONFIDENTIAL

CONFIDENTIAL

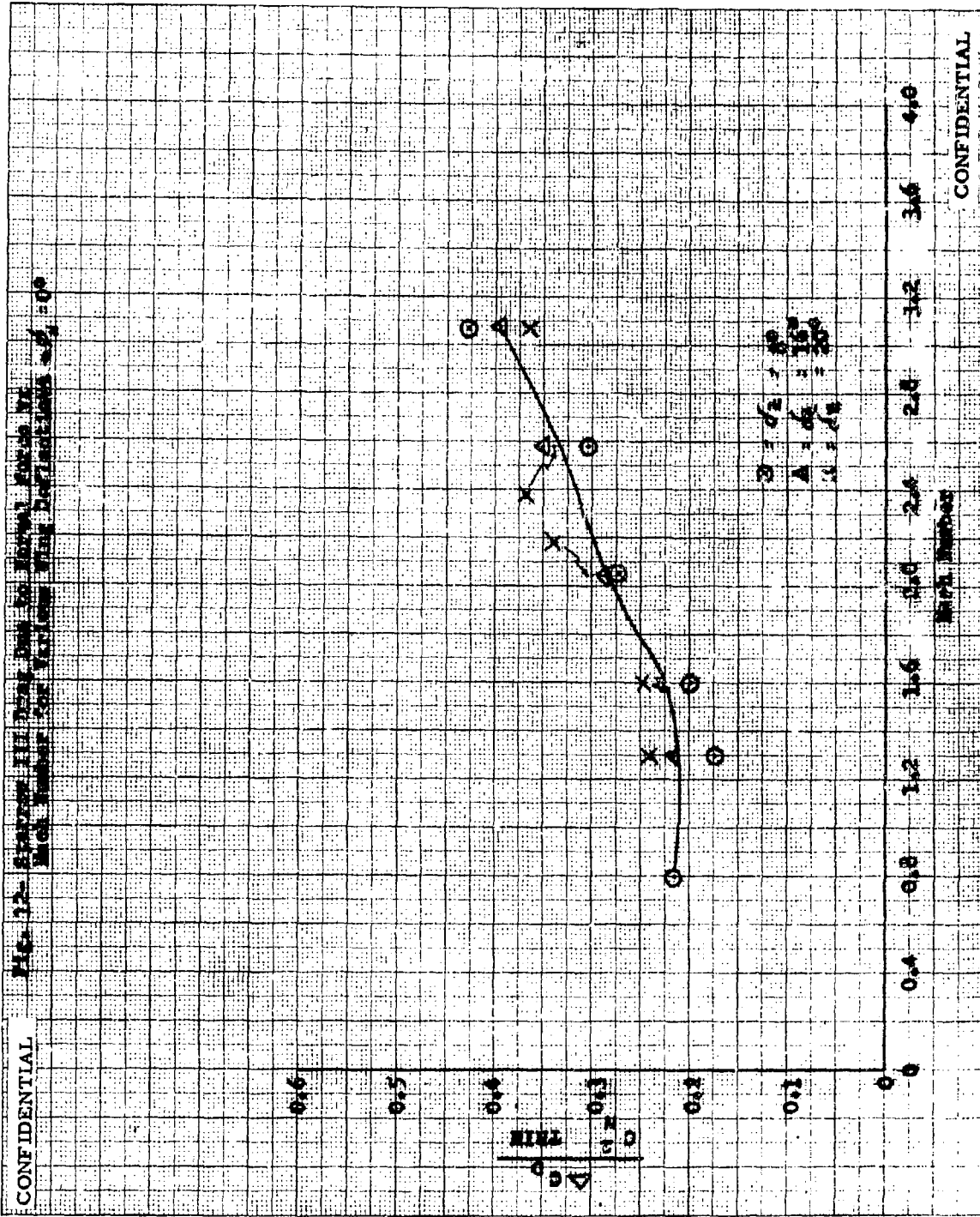
Fig. 11- Spatter III Zero Lift Run
at 1145m/sec

.16
.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0



X-axis

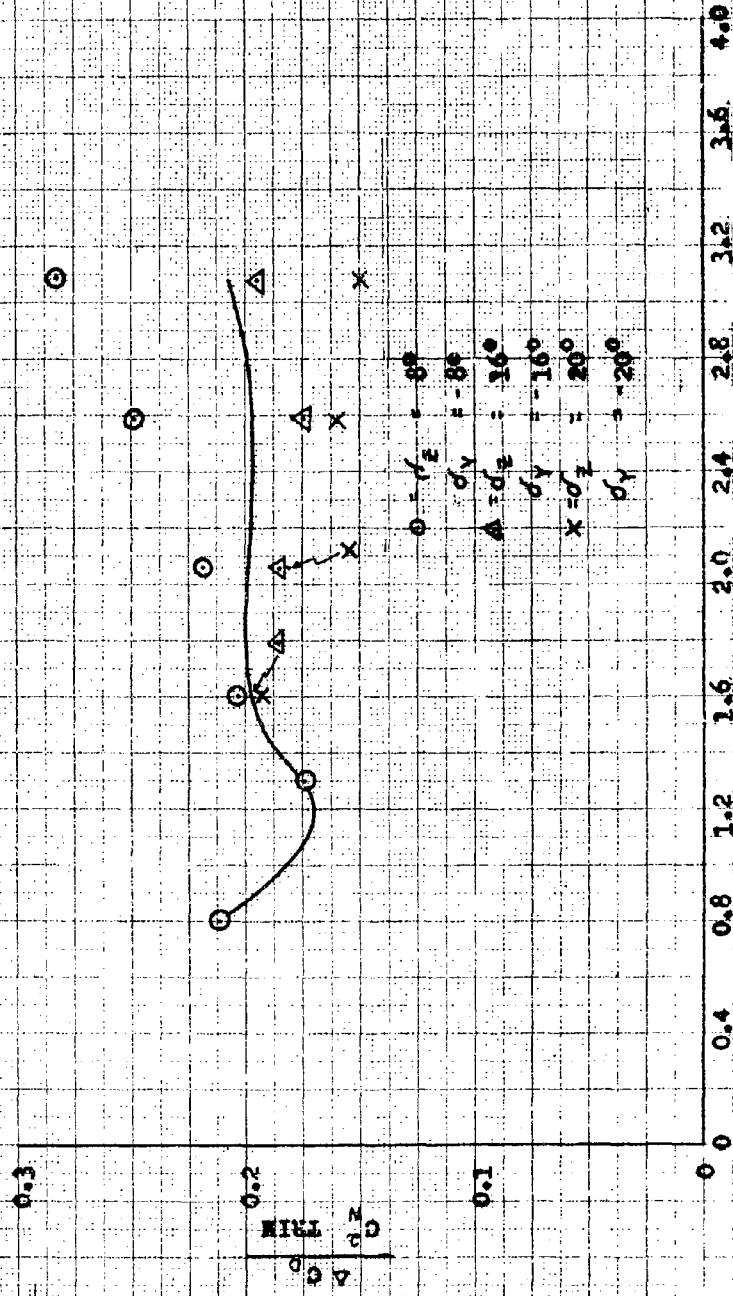
CONFIDENTIAL



CONFIDENTIAL

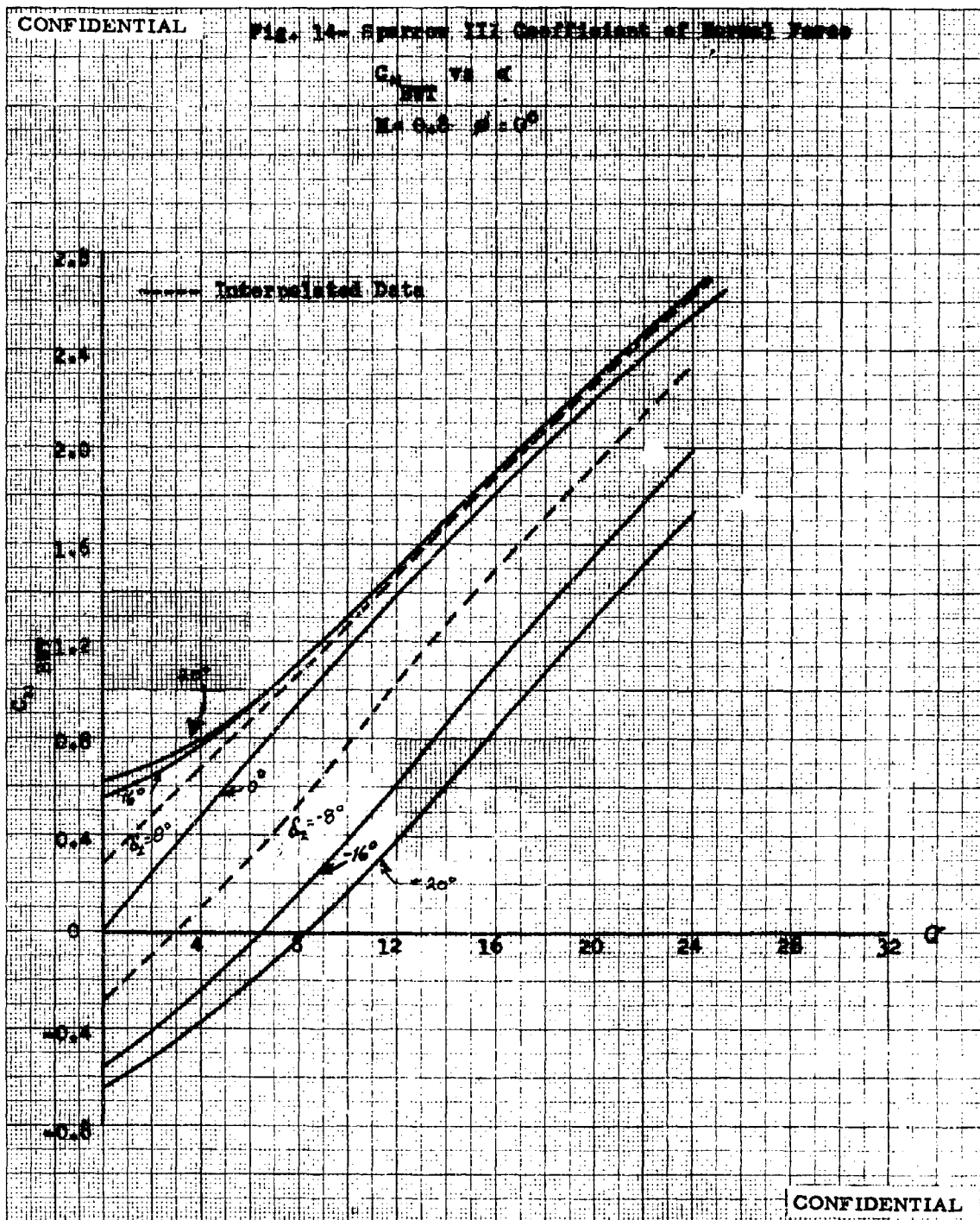
CONFIDENTIAL

Fig. 13-Spartan III Drag Due to Internal Forces vs
Mach Number for Various Wing Deflections $\alpha_N = 45^\circ$



Mach Number

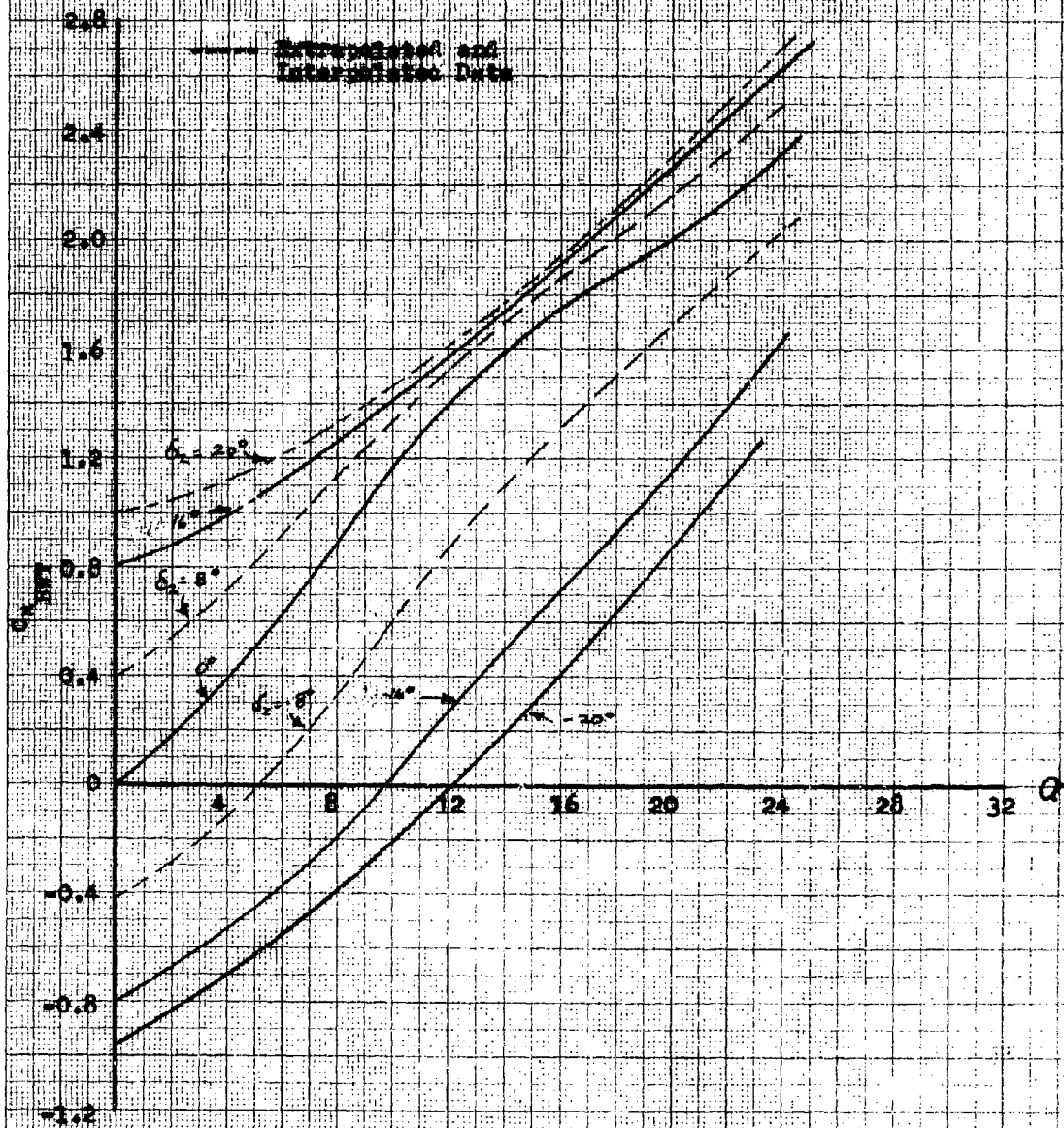
CONFIDENTIAL



CONFIDENTIAL

Fig. 15 - Sparrow III Coefficient of Normal Force

$C_{N, \text{III}}$ vs α
 $M=0.8$ $\beta=45^\circ$



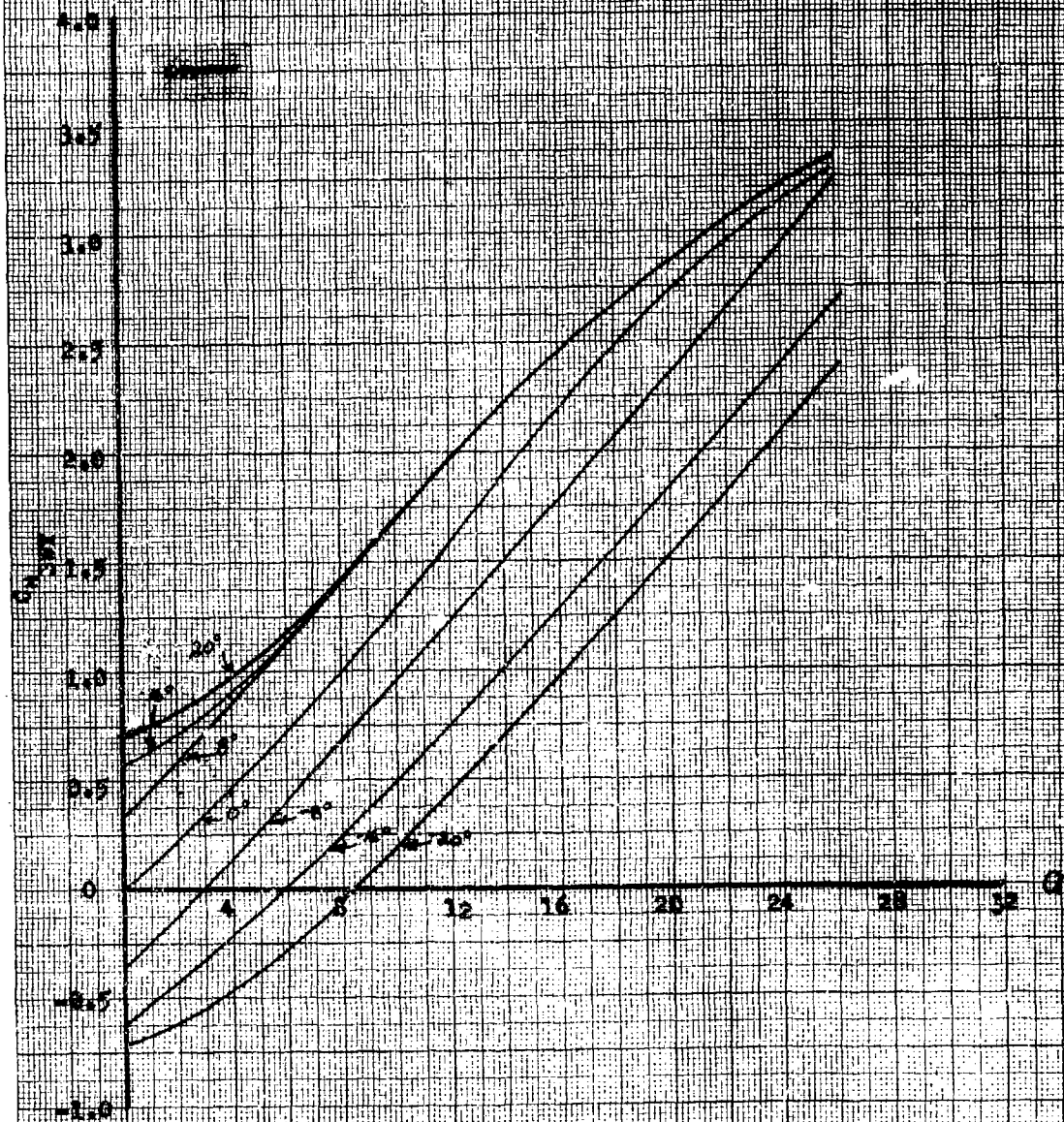
CONFIDENTIAL

CONFIDENTIAL

Fig. 16- Sparrow III Coefficient of Bowed Force

1990 年 12 月 10 日

1990年12月15日



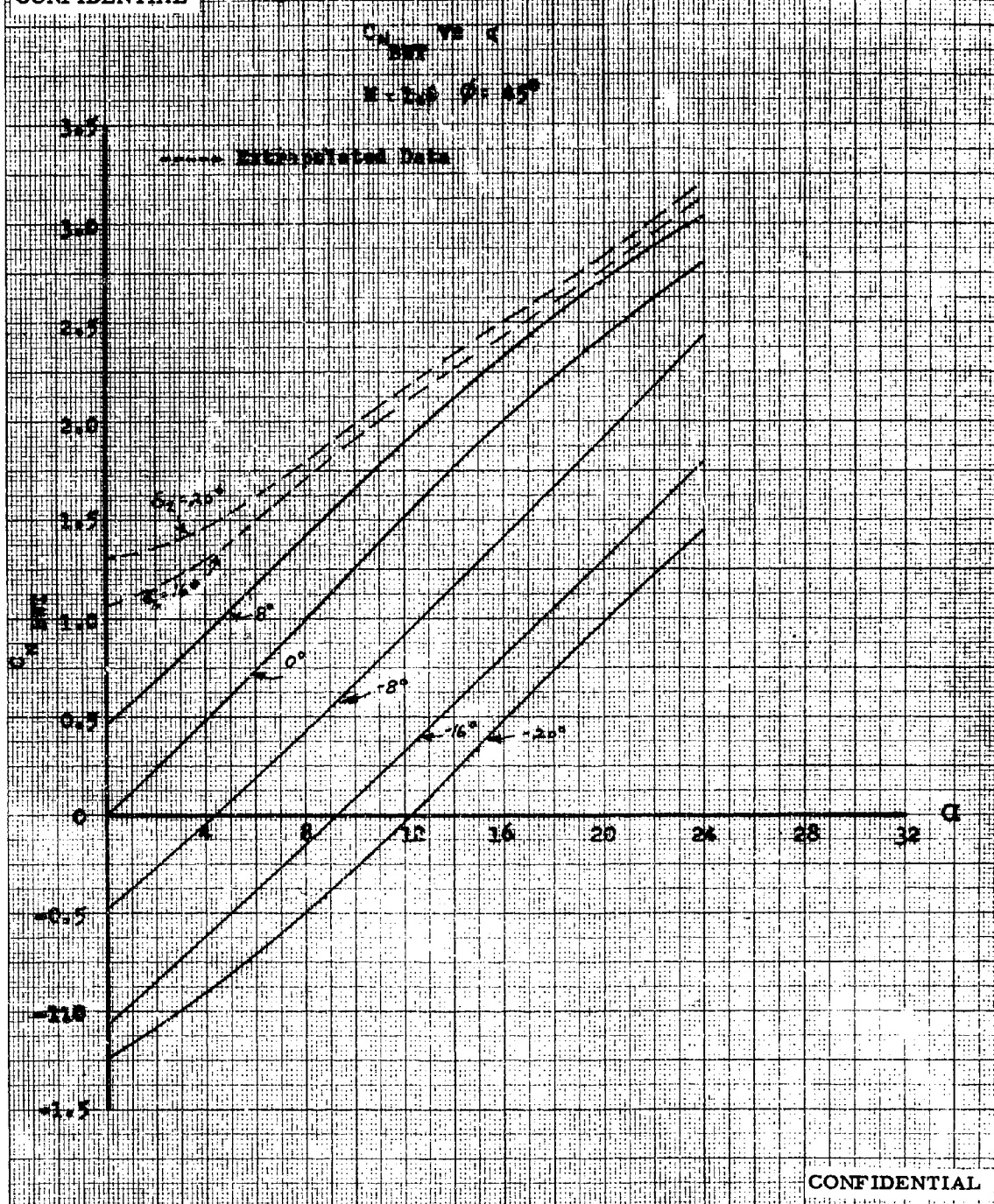
CONFIDENTIAL

CODEX BOOK COMPANY, INC., WORTWOOD, MASSACHUSETTS.
PRINTED IN U. S. A.

NO. 318A. MILLIMETERS. 200 BY 250 DIVISIONS.

CONFIDENTIAL

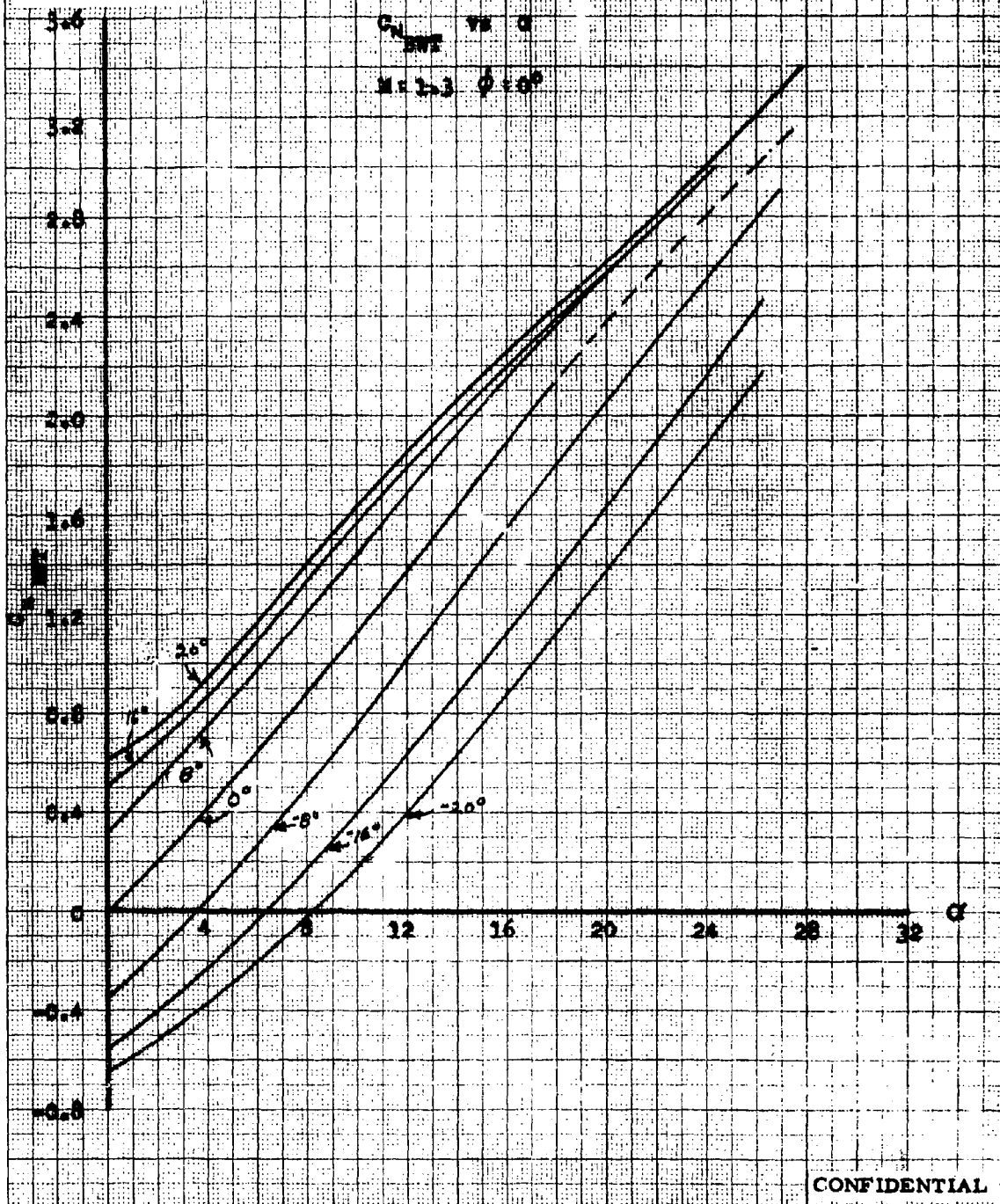
Fig. 17- Sparrow III Coefficient of Normal Force



CONFIDENTIAL

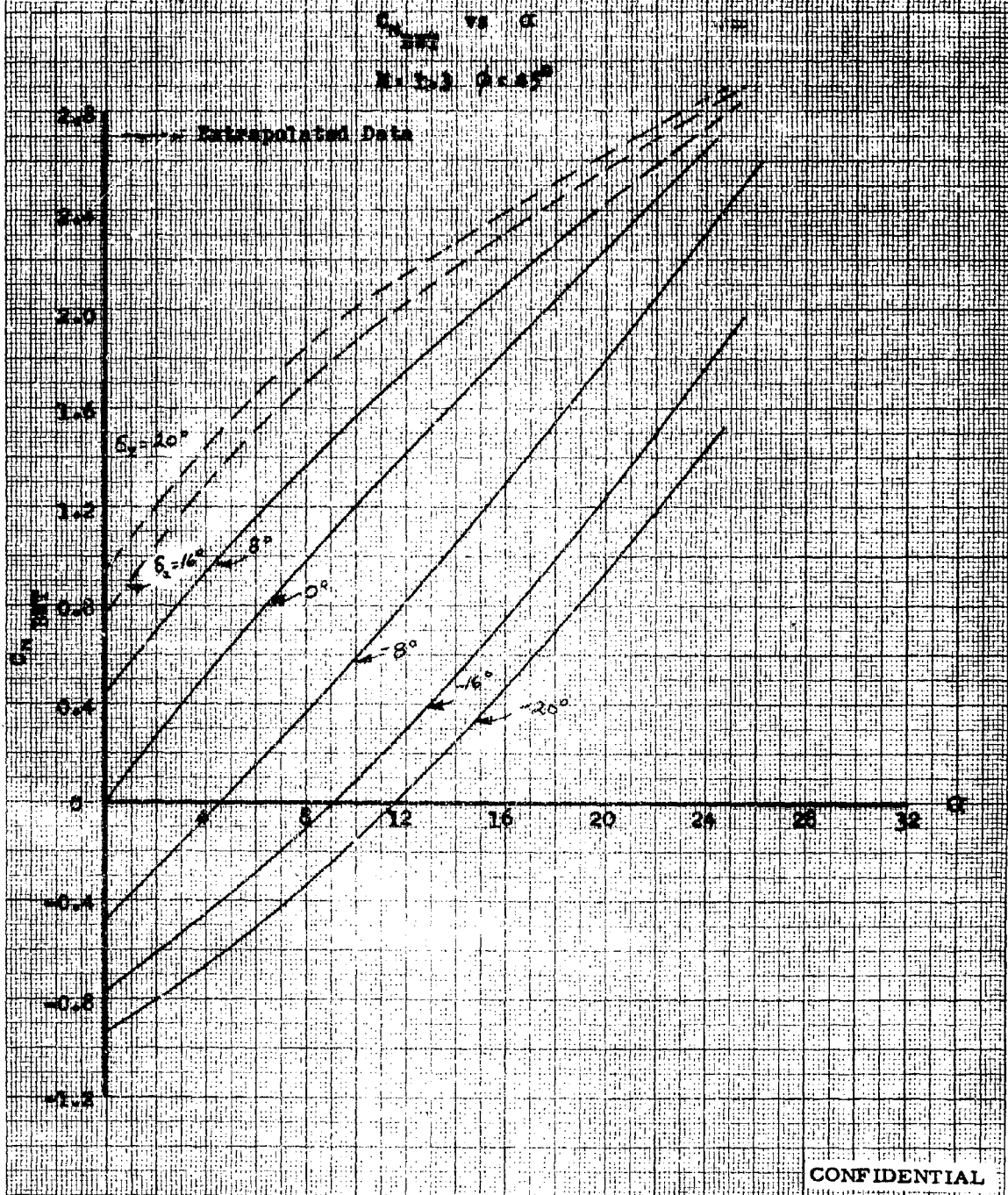
CONFIDENTIAL

Fig. 18. Sparrow III Coefficient of Normal Force



CONFIDENTIAL

Fig. 12- Sparrow III Coefficient of Normal Force



CORDES BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 318A. MILLIMETERS 200 BY 250 DIVISIONS

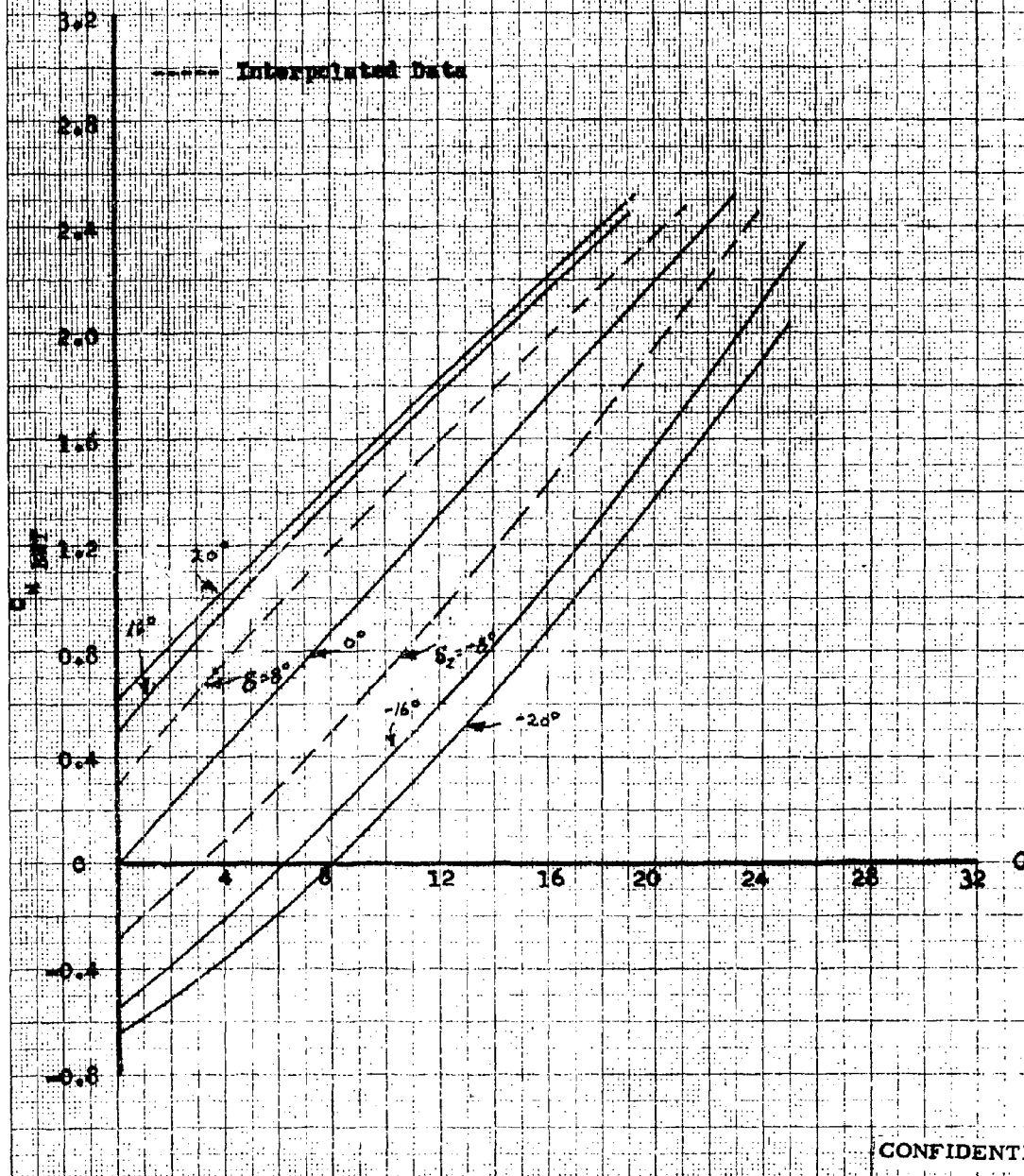
CONFIDENTIAL

CONFIDENTIAL

Fig. 20. Sparrow III Coefficient of Normal Force

C_N NWT vs α

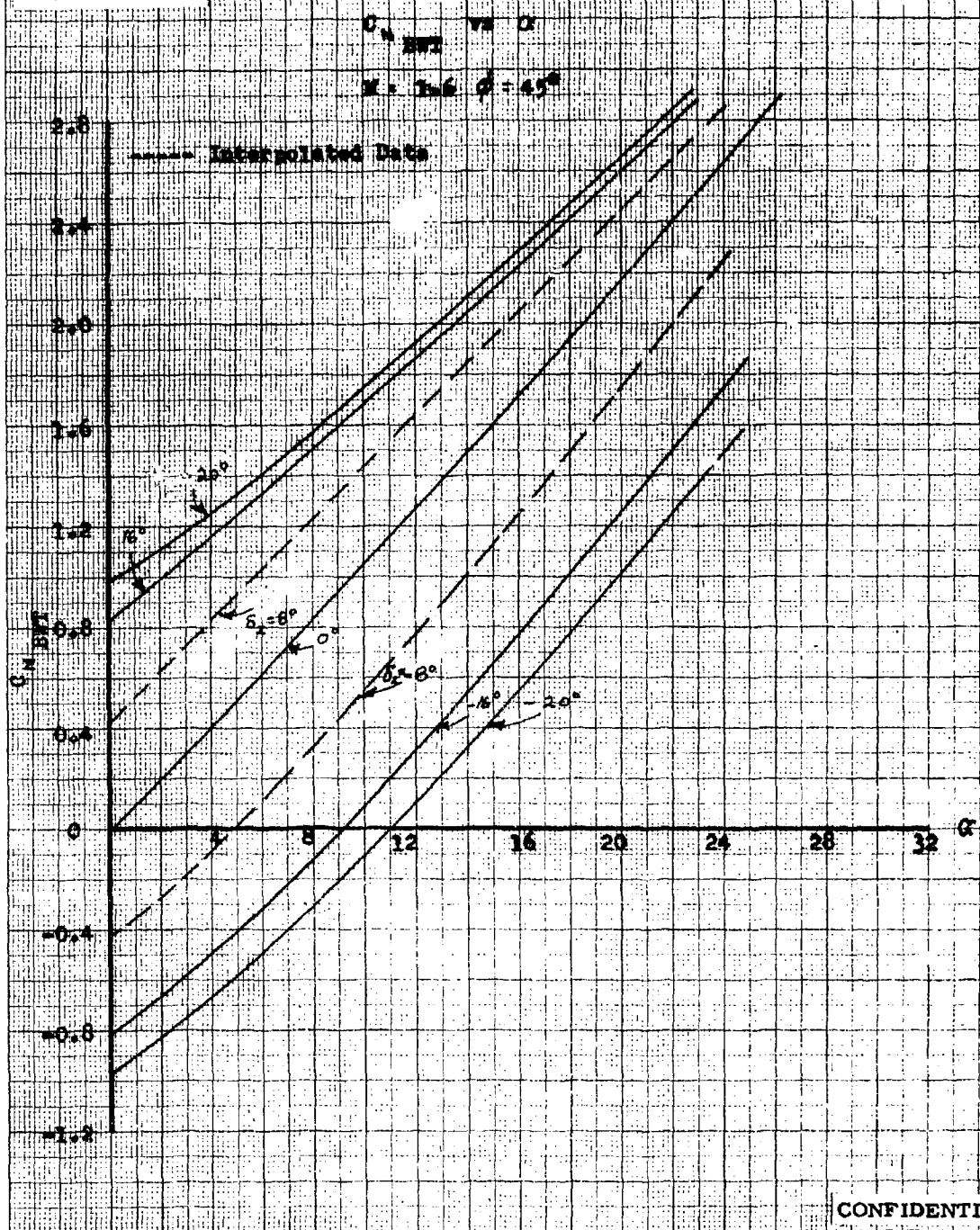
$M = 1.6$ $\phi = 0^\circ$



CONFIDENTIAL

CONFIDENTIAL

Fig. 21- Sparrow III Coefficient of Normal Force



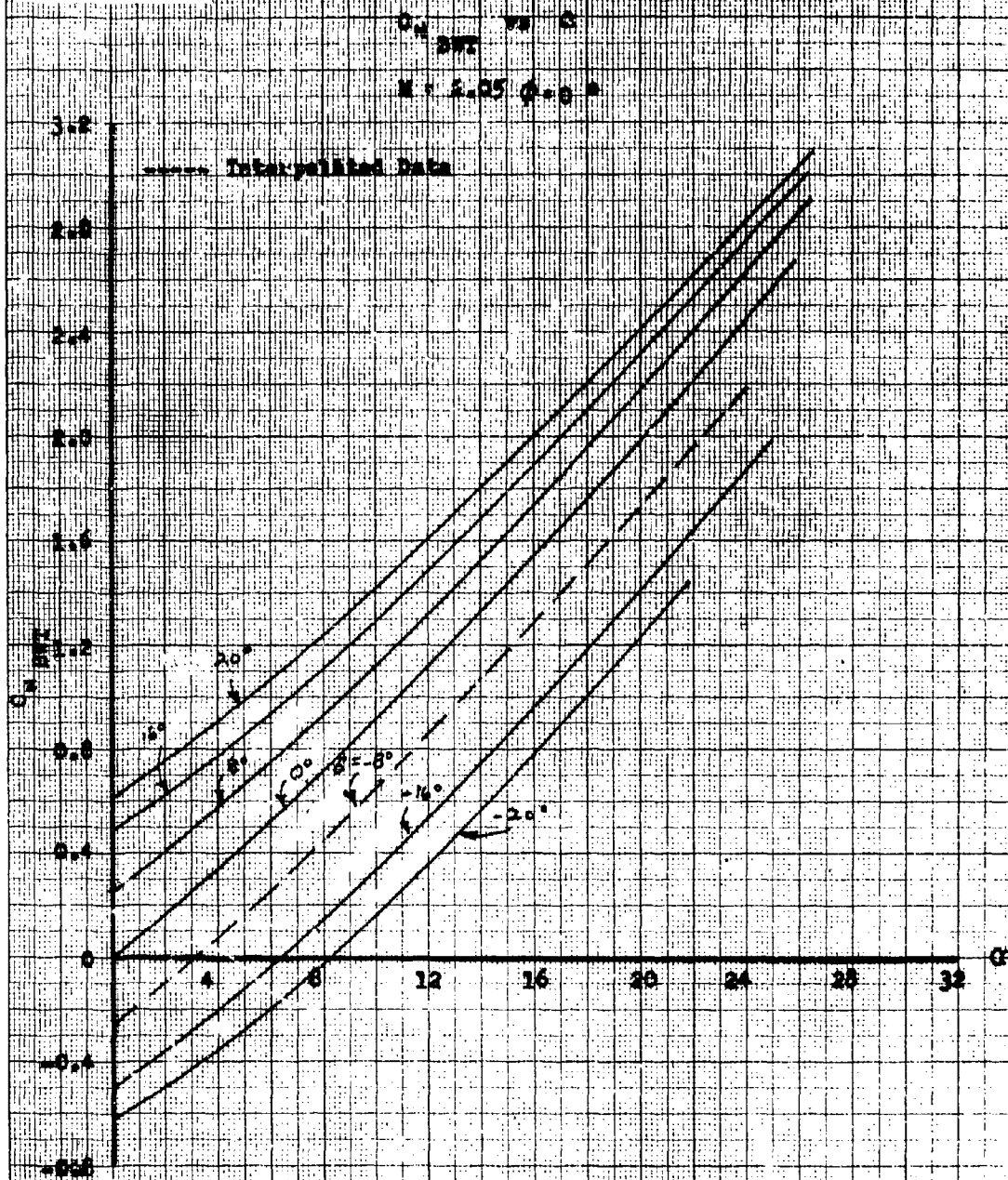
CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
 PRINTED IN U.S.A.

NO. 318A, MILLIMETERS 200 BY 250 DIVISIONS.

CONFIDENTIAL

CONFIDENTIAL

Fig. 25: Sparrow III Coefficient of Thermal Expansion



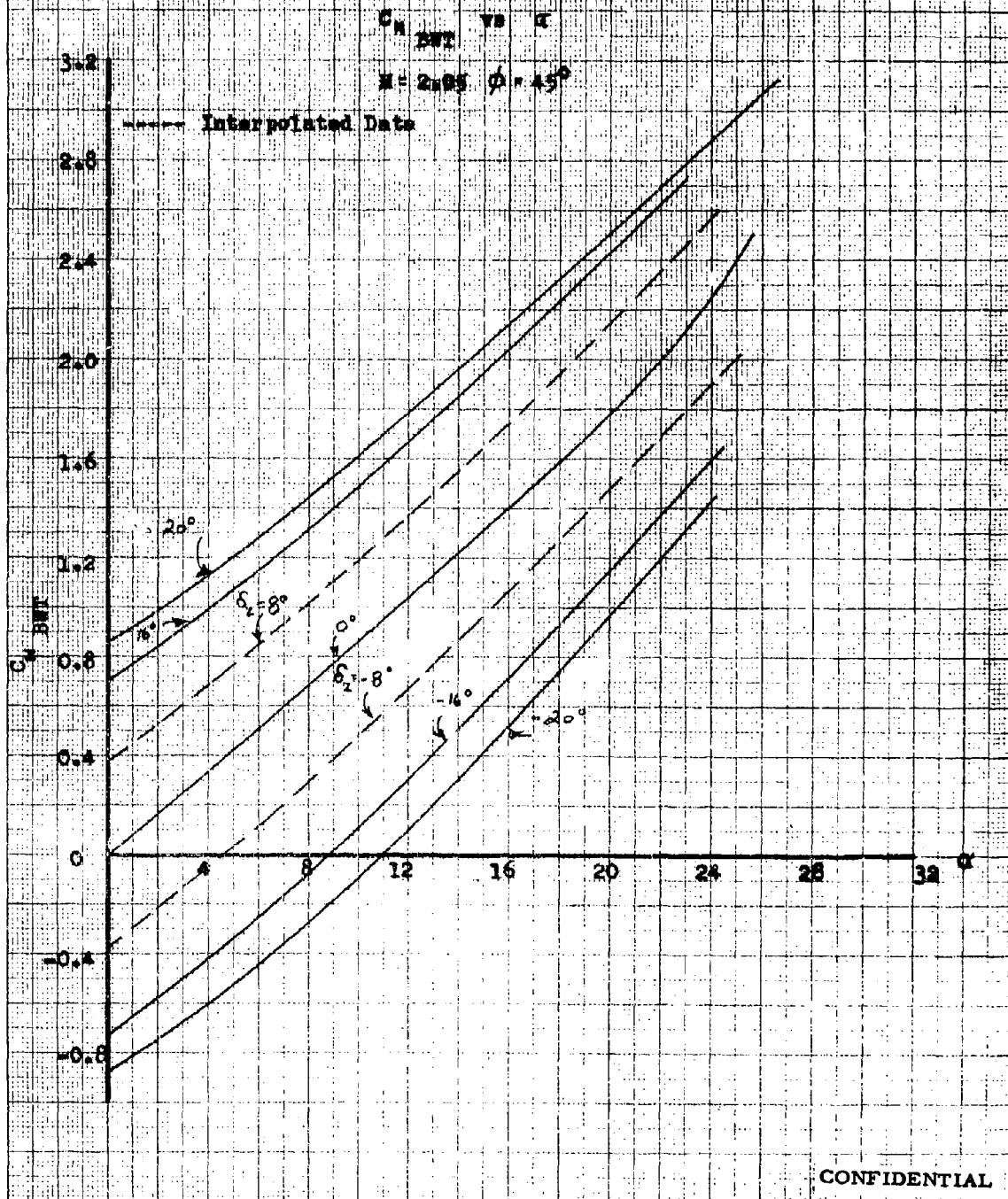
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS
PRINTED IN U.S.A.

NO. 318A. MILLIMETERS 200 BY 250 DIVISIONS

CONFIDENTIAL

CONFIDENTIAL

Fig. 23- Sparrow III Coefficient of Normal Force



CODER BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS
PRINTED IN U.S.A.

NO. 319A MILLIMETERS 300 BY 330 DIVISIONS

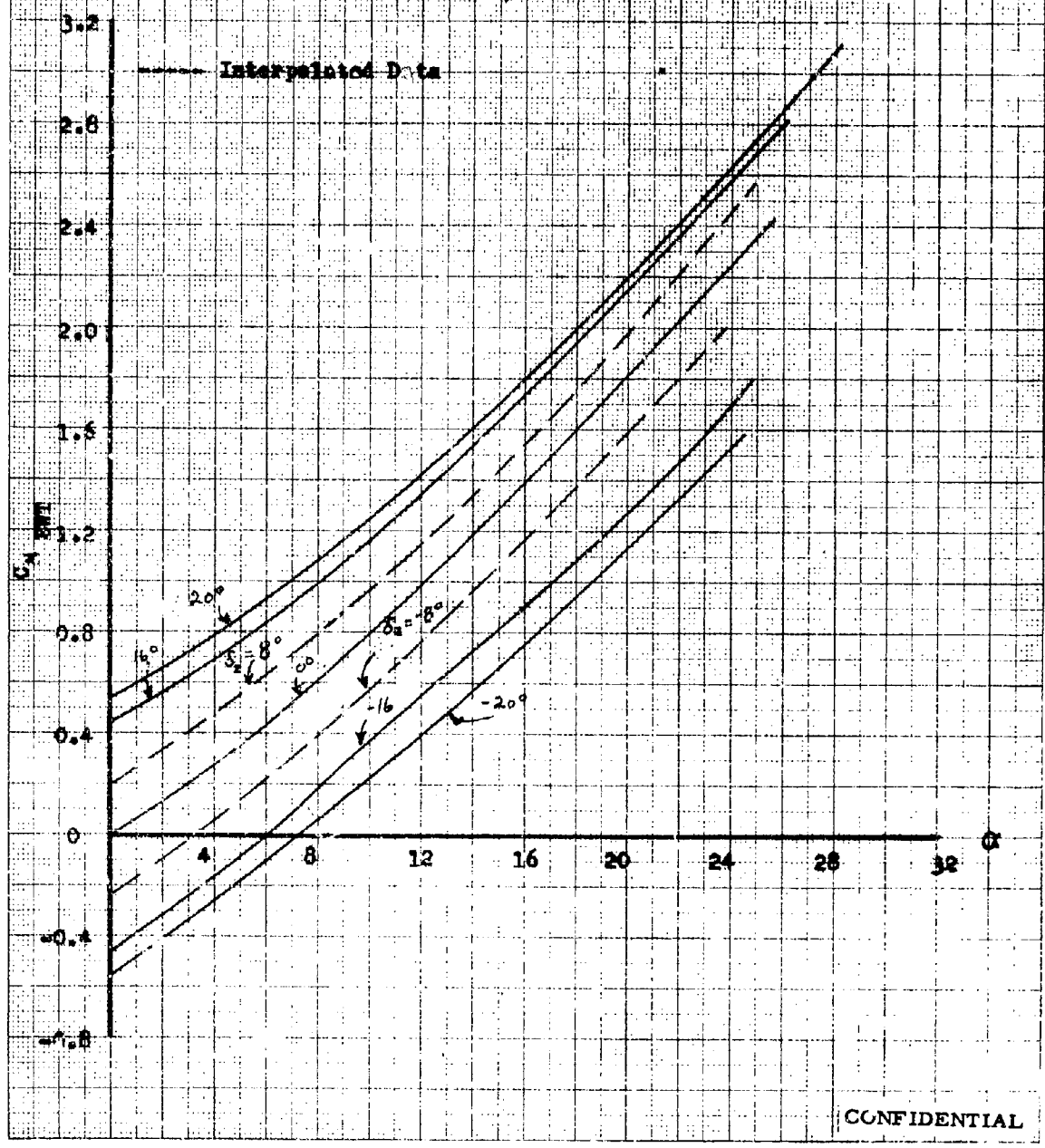
CONFIDENTIAL

CONFIDENTIAL

Fig. 24- Sparrow III Coefficient of Normal Force

$C_{N \text{ DWT}}$ vs α

$M = 2.58 \quad \phi = 0^\circ$



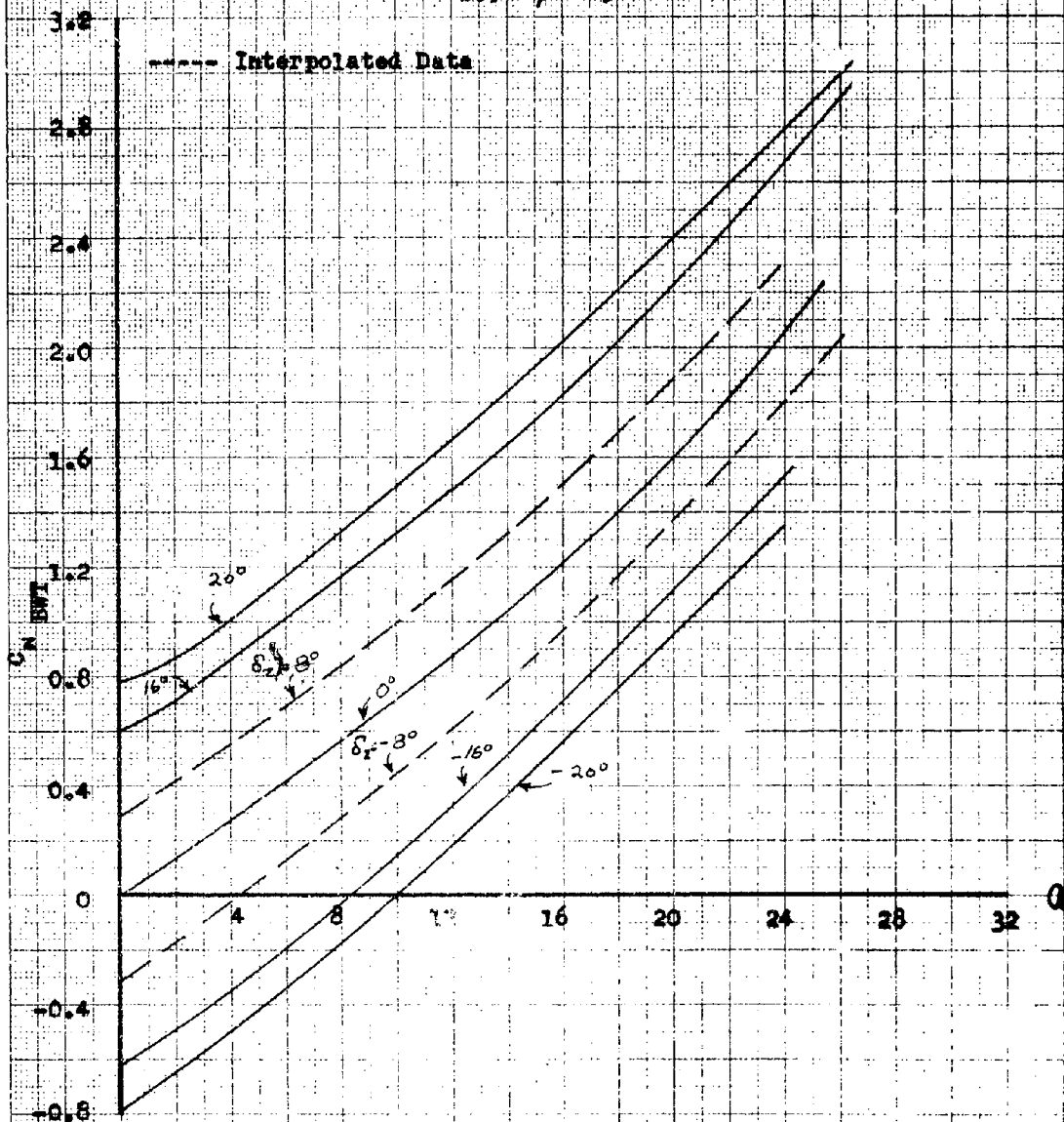
CONFIDENTIAL

CONFIDENTIAL

Fig. 25- Sparrow III Coefficient of Normal Force

$C_{N \text{ BWT}}$ vs α

$M = 2.58 \quad \phi = 45^\circ$



CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS
PRINTED IN U.S.A.

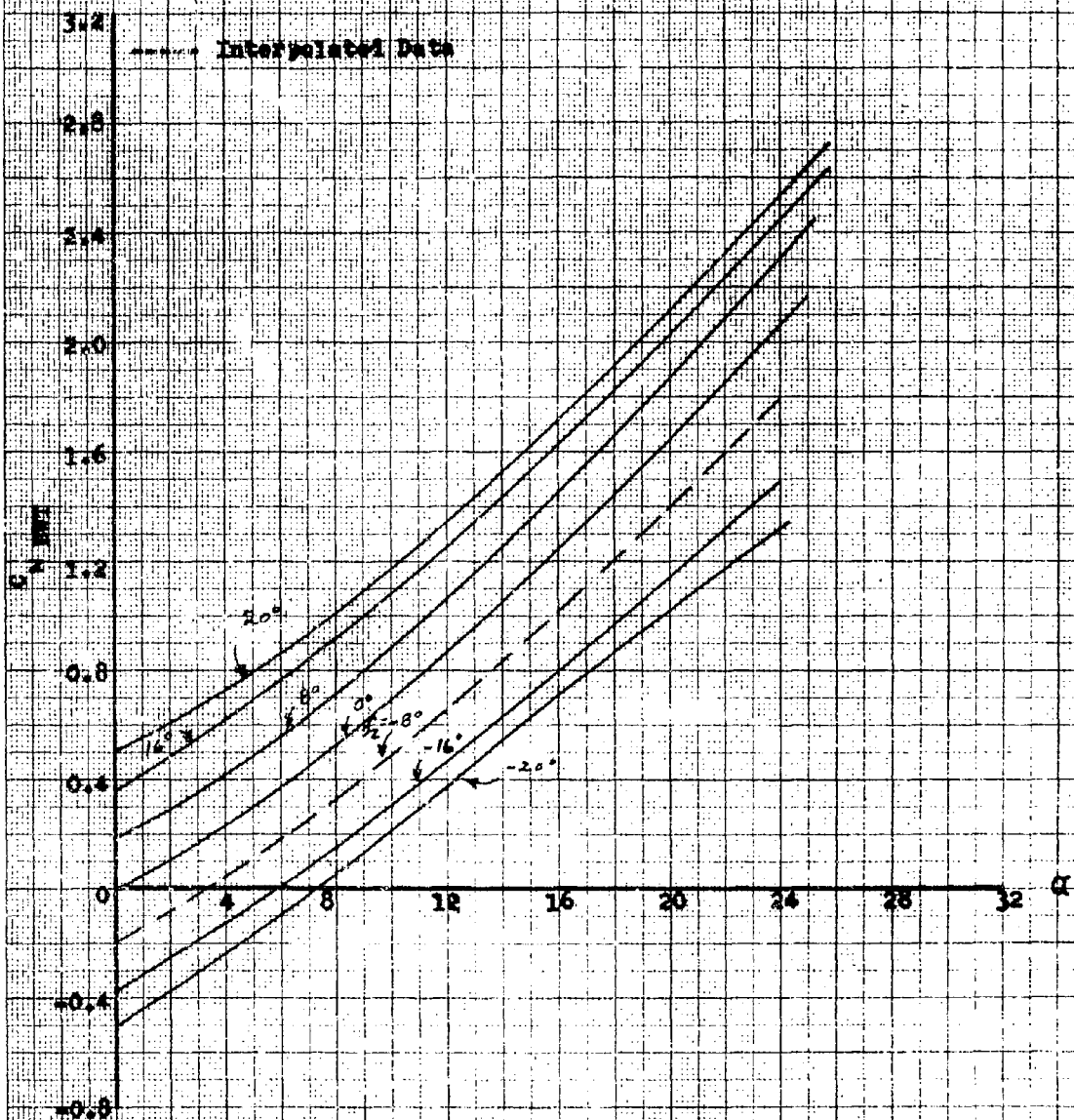
NO. 319A. MILLIMETERS 200 BY 2 1/2 DIVISIONS.

CONFIDENTIAL

CONFIDENTIAL

Fig. 26- Sparrow III Coefficient of Normal Force

C_N vs α
 $N = 3.06$ $\phi = 20^\circ$



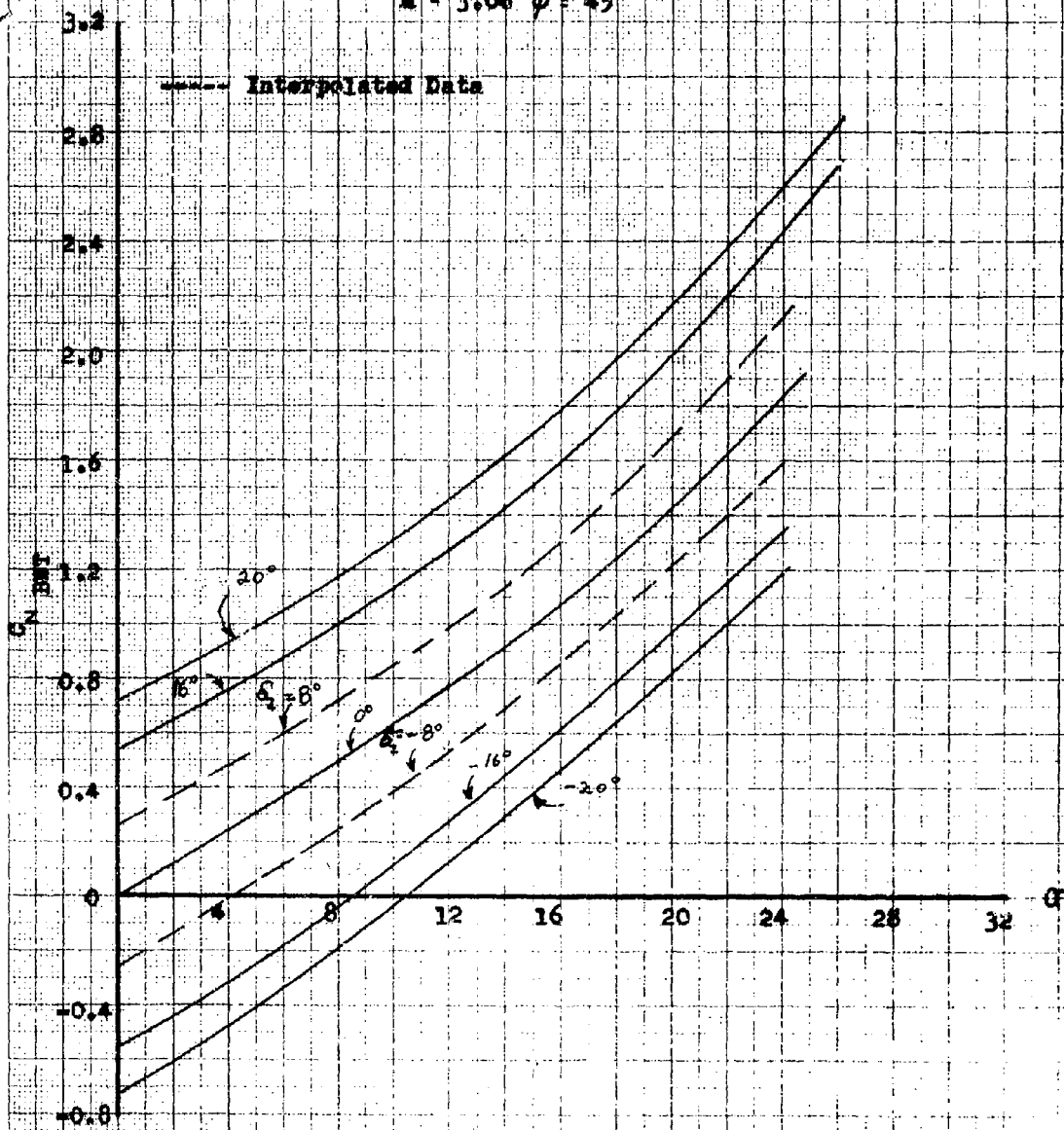
CONFIDENTIAL

CONFIDENTIAL

Fig. 27- Sparrow III Coefficient of Normal Force

C_N vs α
BWT

$M = 3.06 \phi = 45^\circ$



CODER BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETER 2.5 BY 2.5 DIVISIONS

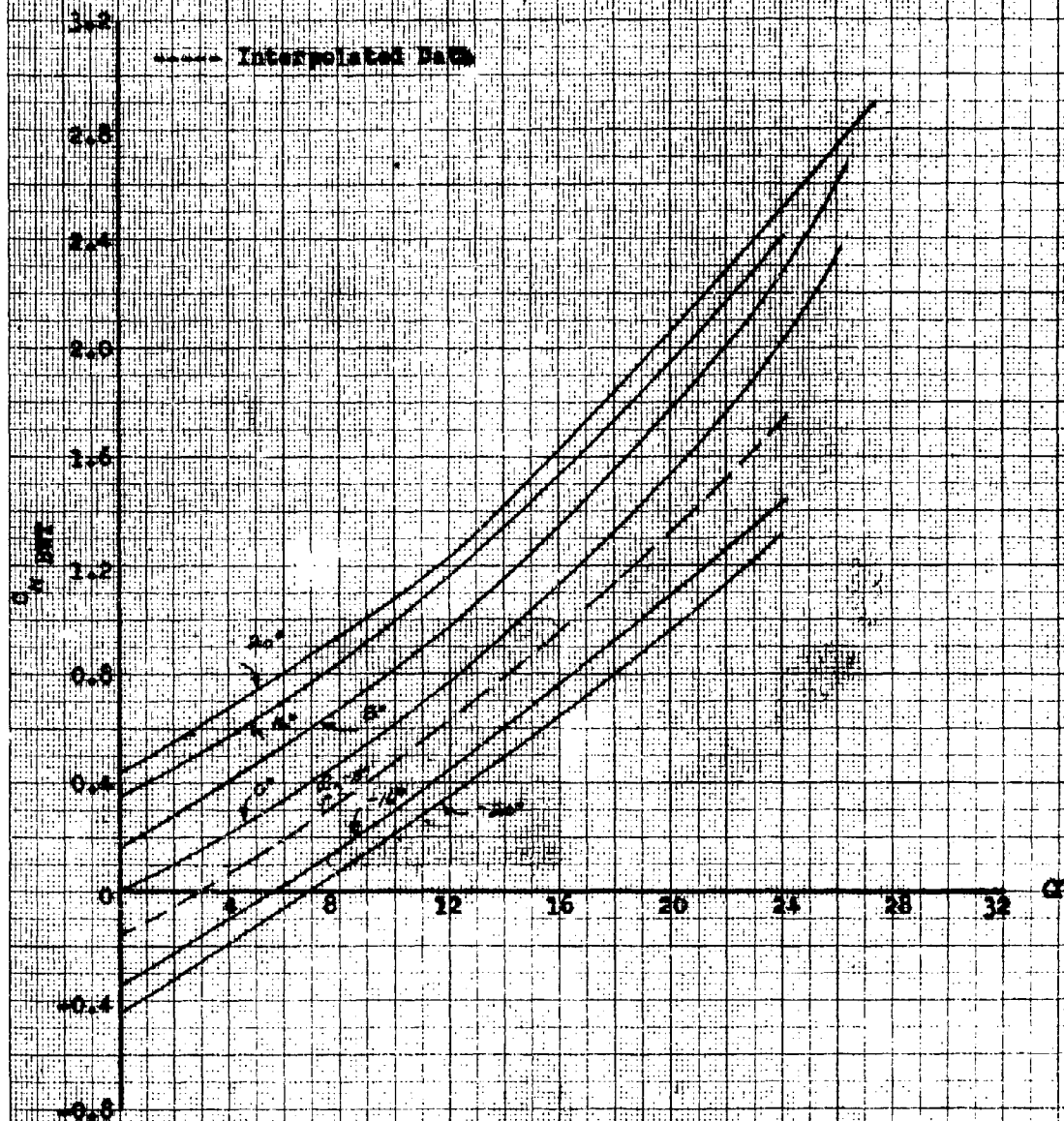
CONFIDENTIAL

CONFIDENTIAL

Fig. 25- Sparrow III Coefficient of Normal Force

C_N vs α
SWT

$\mu = 3.45 \phi = 0^\circ$



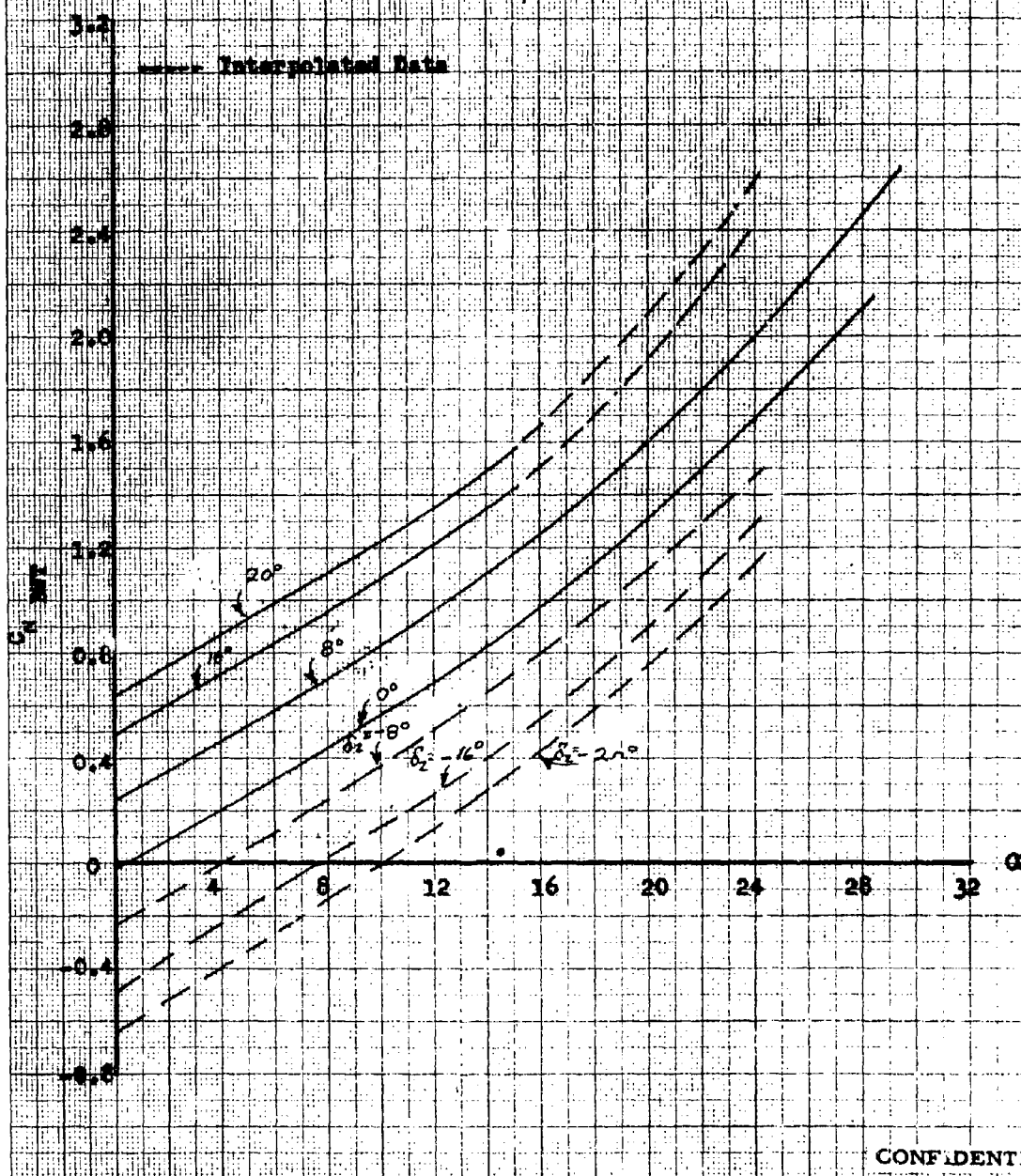
CONFIDENTIAL

CONFIDENTIAL

Fig. 29 Sparrow III Coefficient of Normal Force

C_N vs α

$M = 3.48 \quad \phi = 45^\circ$

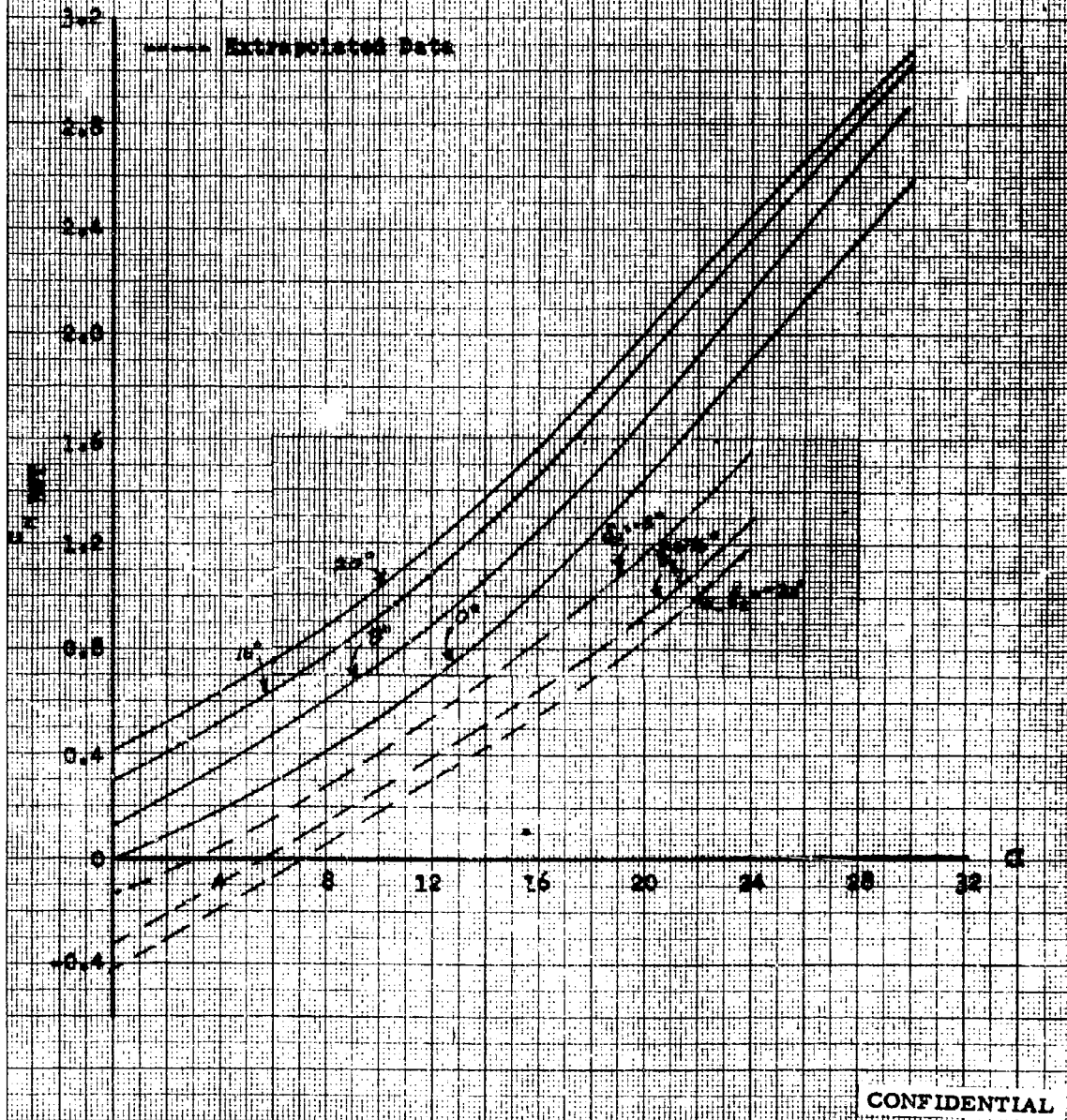


CONFIDENTIAL

CONFIDENTIAL

Fig. 10- Spectrum III Coefficients of Normal Form

$C_{N \text{ DNT}} \text{ vs } Q$
 $M = 3.58 \quad Q = 0.5$

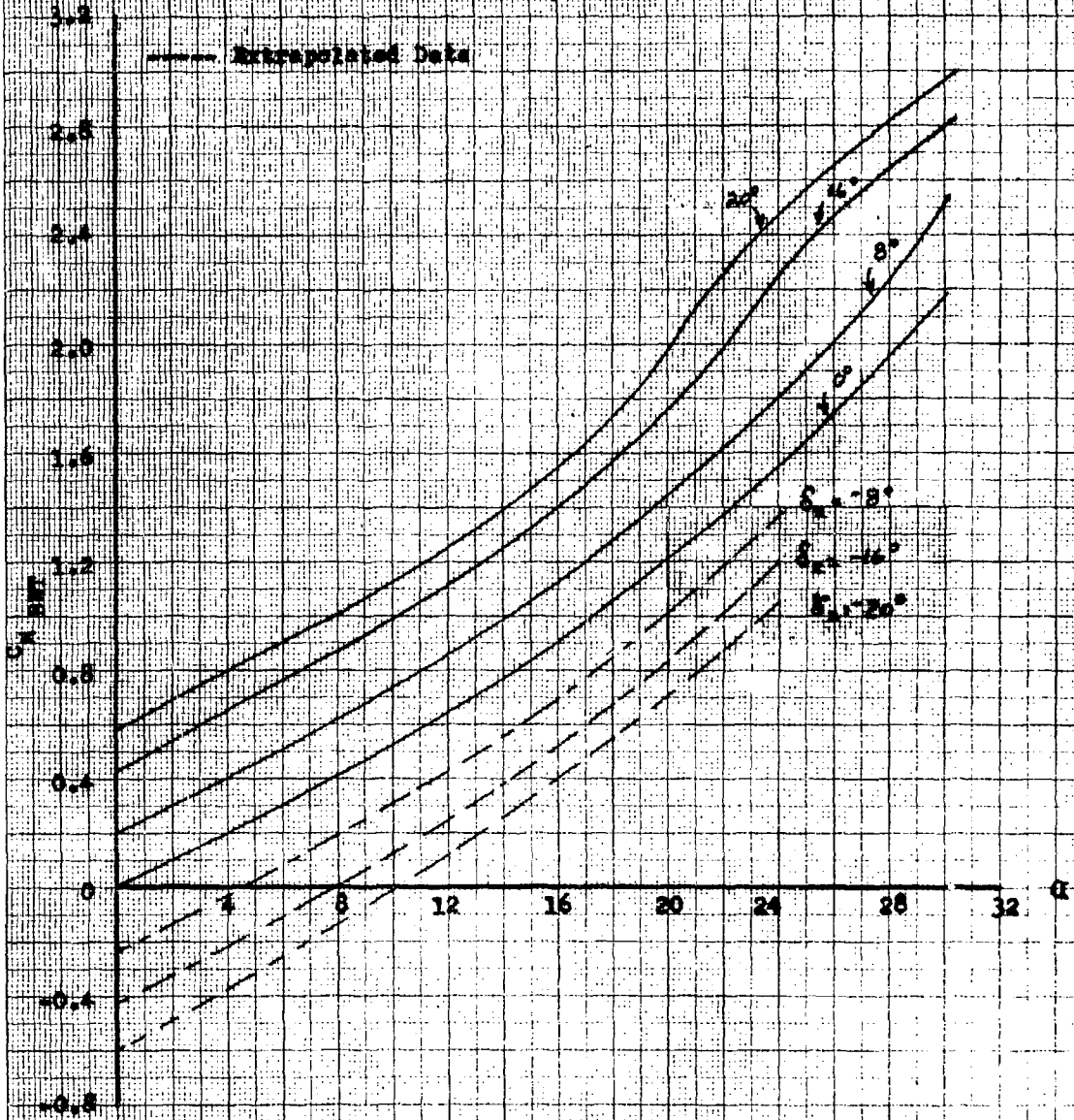


CONFIDENTIAL

Fig. 11- Sperry III Coefficient of Normal Force

$C_{N \text{ BWT}}$ vs α

$M = 3.98 \quad \phi = 45^\circ$



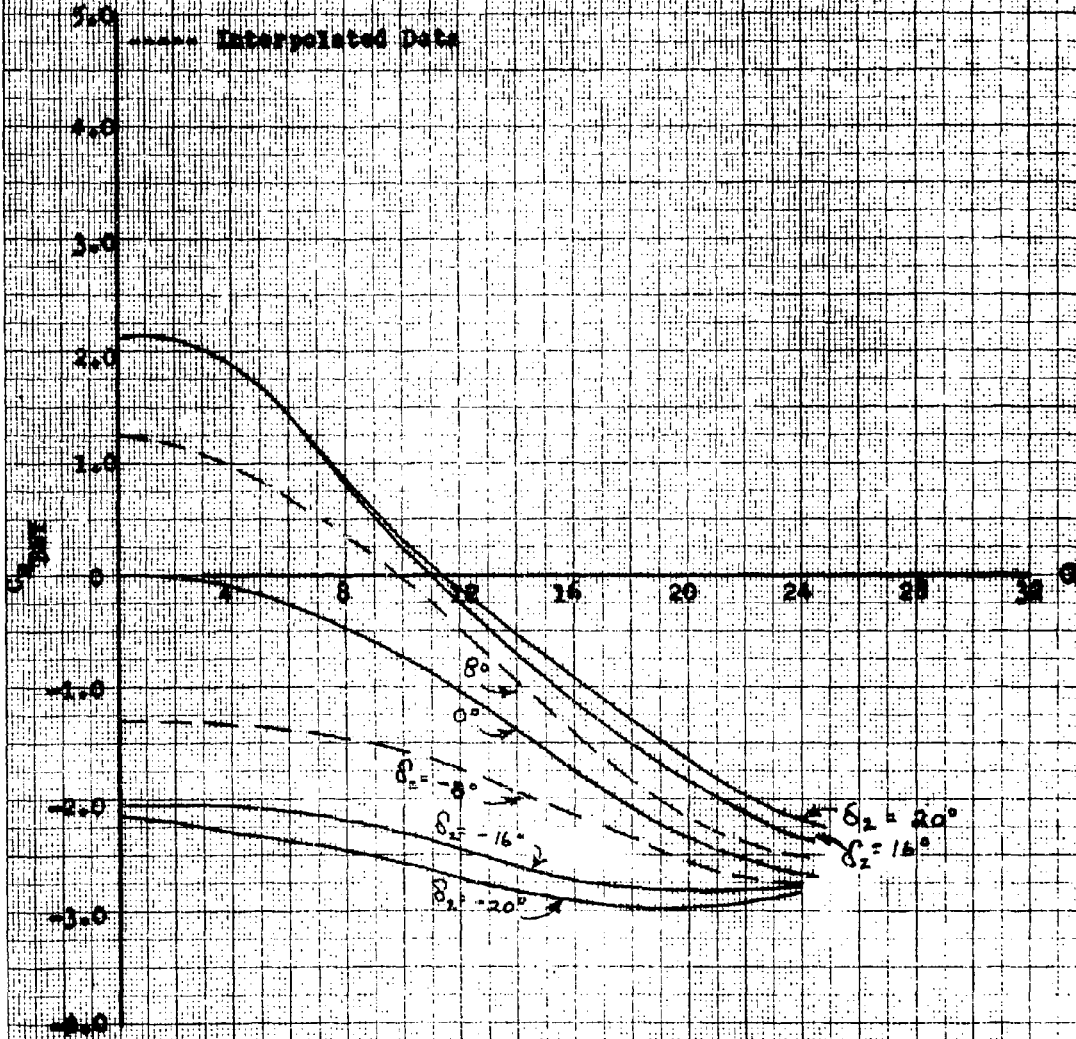
CONFIDENTIAL

CONFIDENTIAL.

Fig. 32- SPART. # III Flushing Agent Coefficient

$C_{\text{SPART}} \text{ vs } \alpha$

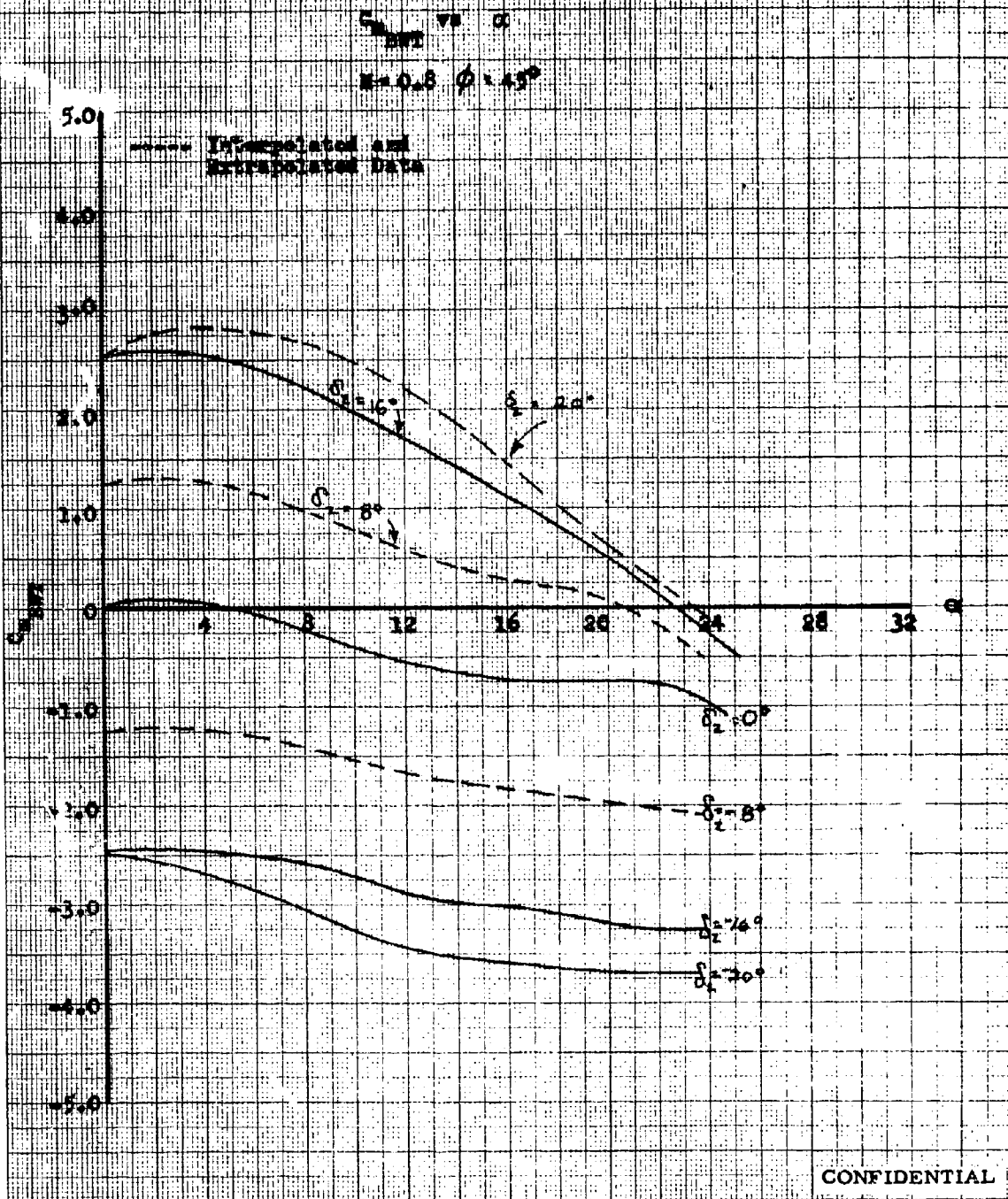
$K=0.8 \quad \phi=0^\circ$



CONFIDENTIAL

CONFIDENTIAL

Fig. 31- Sparrow III Fitting Moment Coefficient



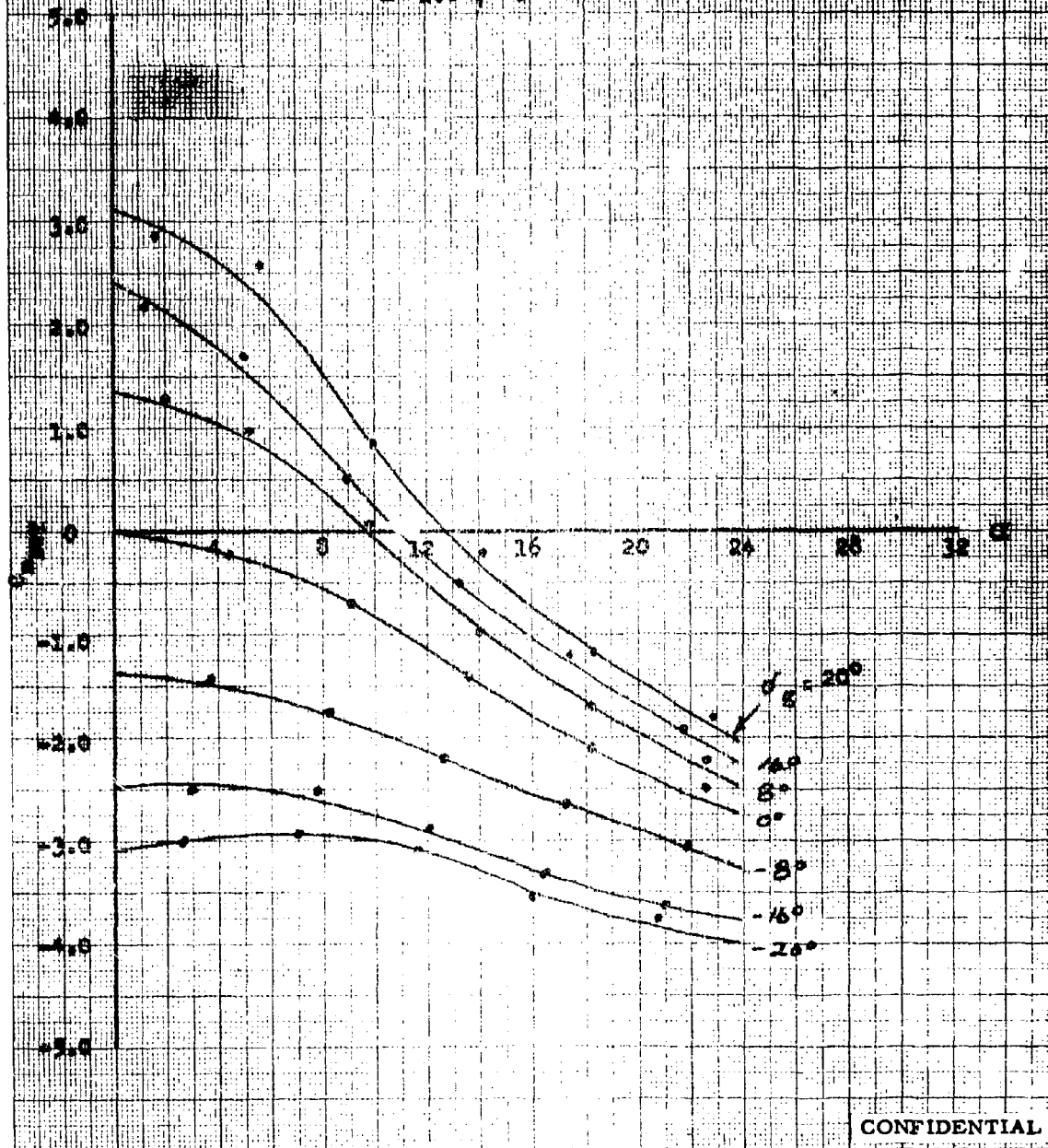
CONFIDENTIAL

CONFIDENTIAL

Fig. 34- Sparrow III Pitching Moment Coefficients

$C_{m, \text{BWT}}$ vs α

$M = 1.0 \quad \phi = 0^\circ$

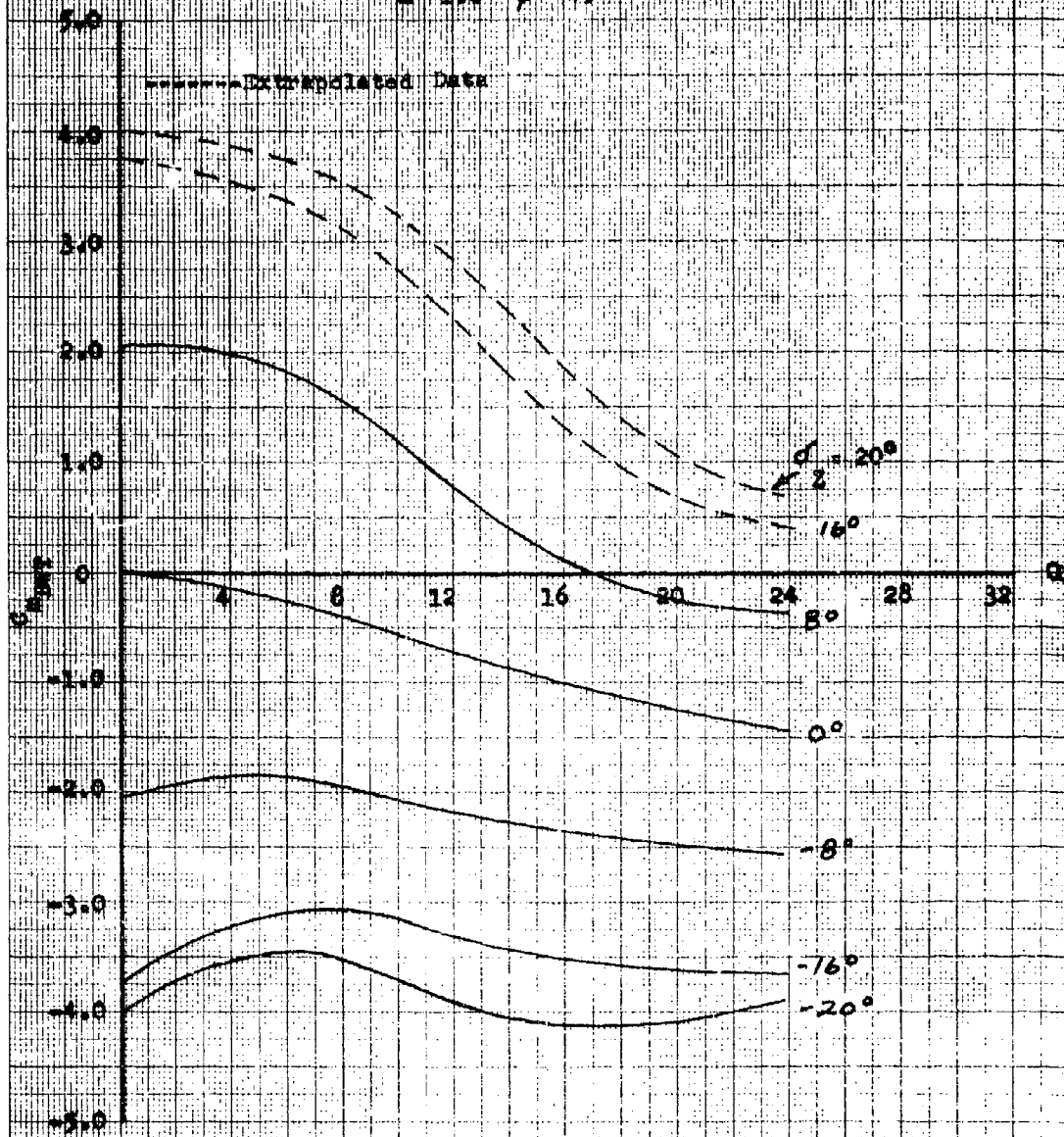


CONFIDENTIAL

CONFIDENTIAL

Fig. 35- Sparrow III Pitching Moment Coefficient

$C_{M, BMT}$ vs α
 $M = 1.0$ $\phi = +5^\circ$



CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.

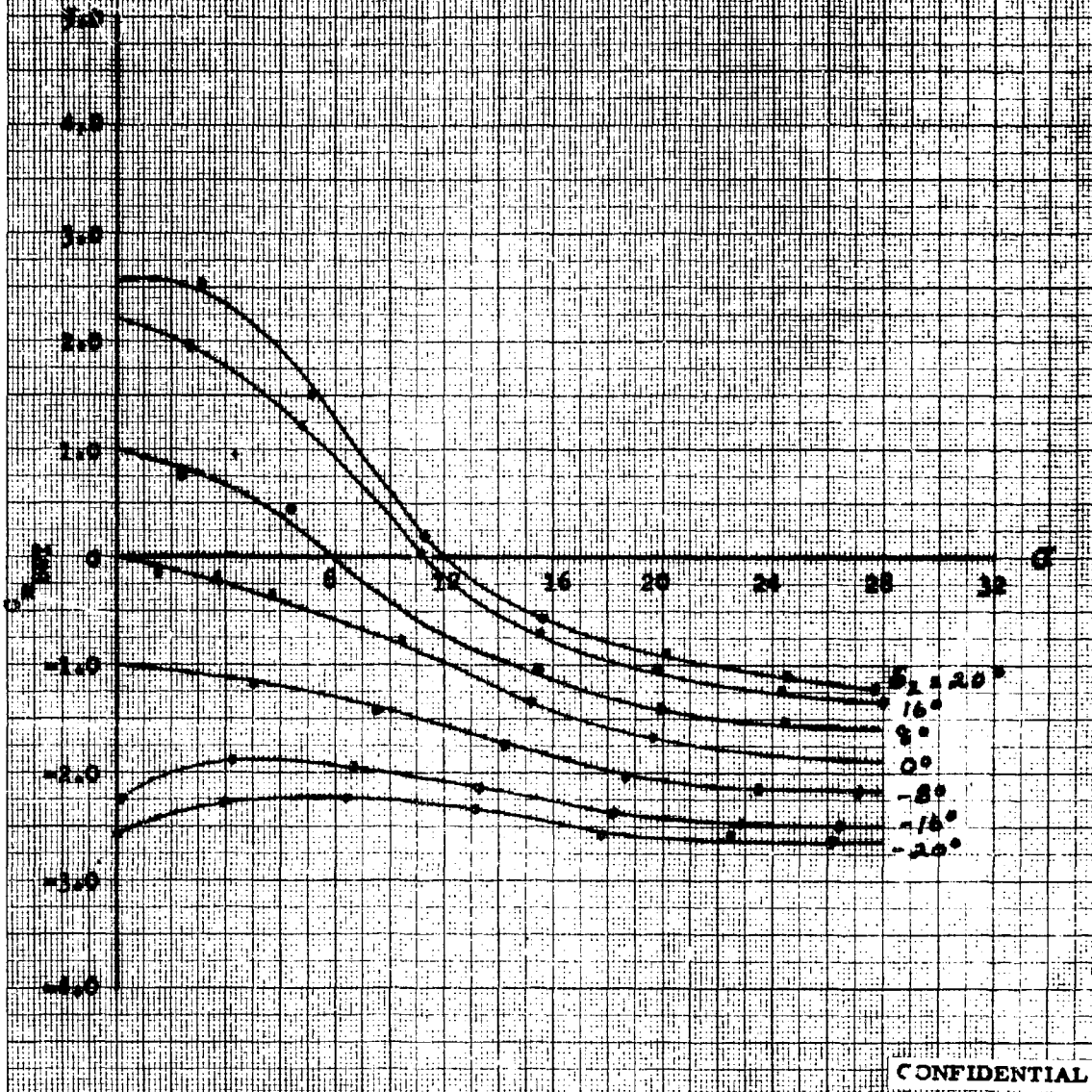
NO. 319A. MILLIMETERS 200 BY 250 DIVISIONS.

CONFIDENTIAL

CONFIDENTIAL

Fig. 34- SPERRY III Rolling Moment Coefficient

C_{RM} vs α
 $R=1.5$ $\beta=0^\circ$



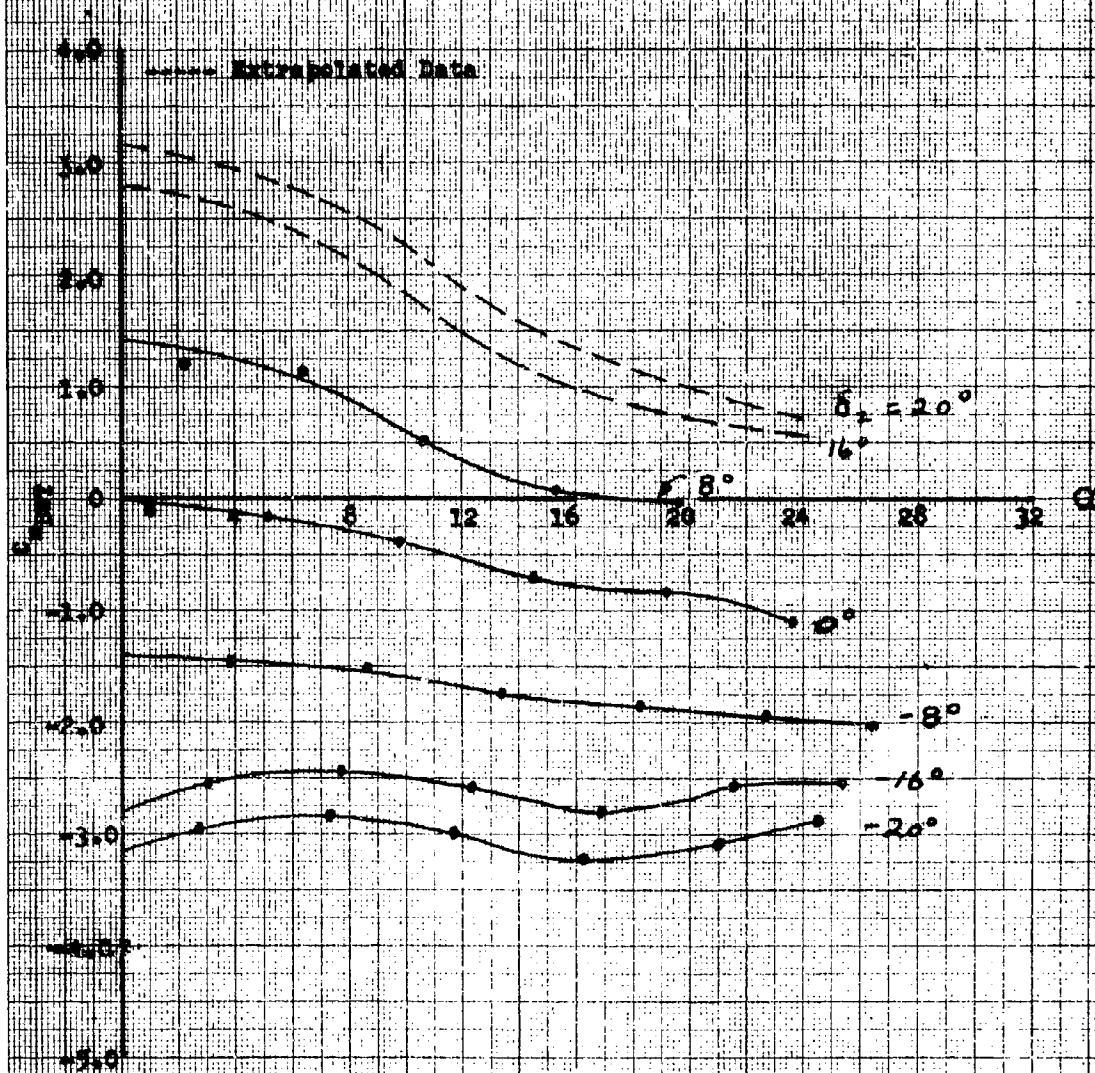
CONFIDENTIAL

CONFIDENTIAL

Fig. 37- Sparrow III Pitching Moment Coefficient

$C_{m, DAT}$ vs α

$M=1.3$ $\phi=45^\circ$



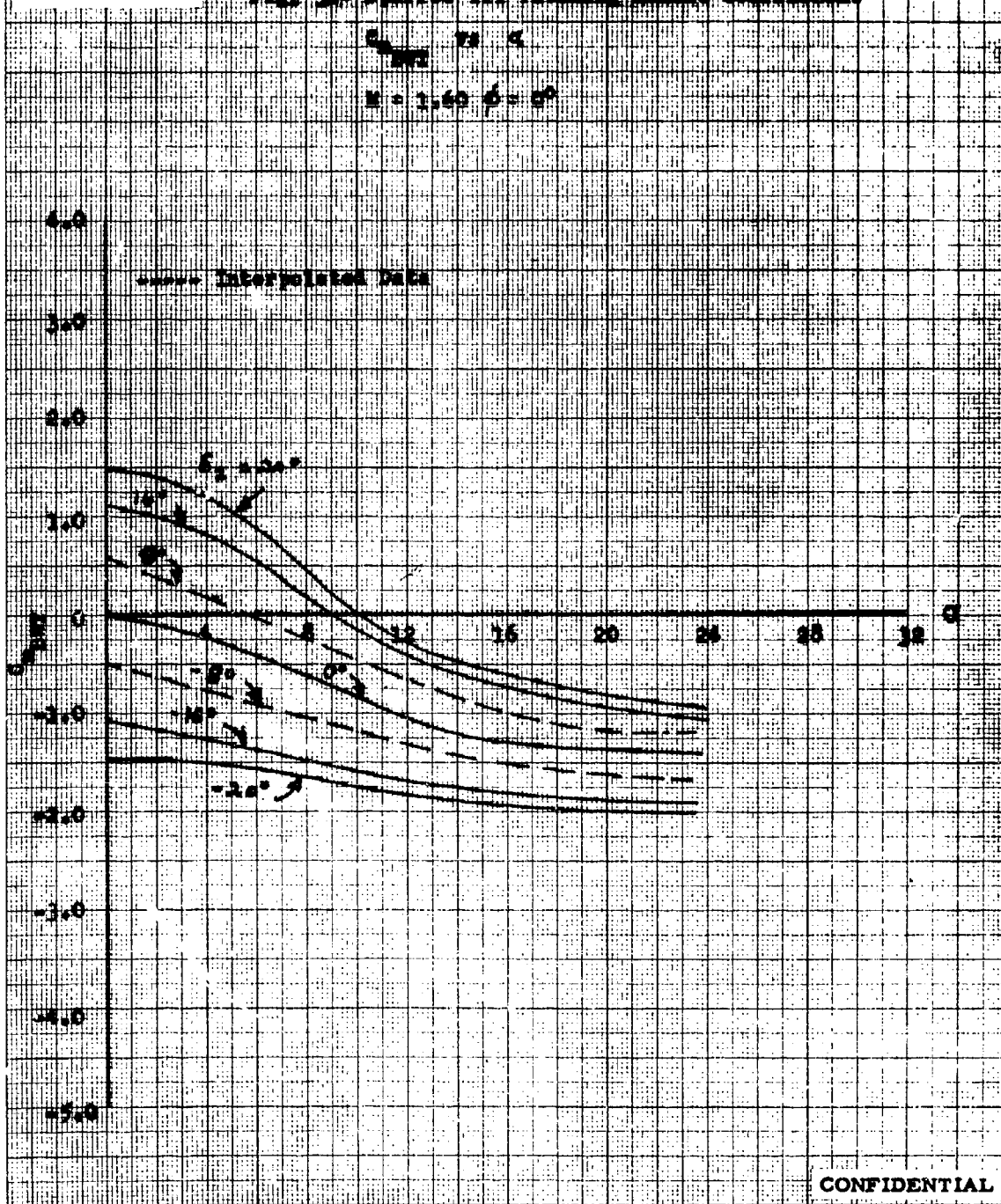
CONFIDENTIAL

CONFIDENTIAL

Fig. 30. Spectrum III: Plotting Moment Coefficient

$$C_m = \frac{M}{\rho V^2 b^2} \quad \text{vs } \alpha$$

$$M = 1.60 \quad \phi = 0^\circ$$

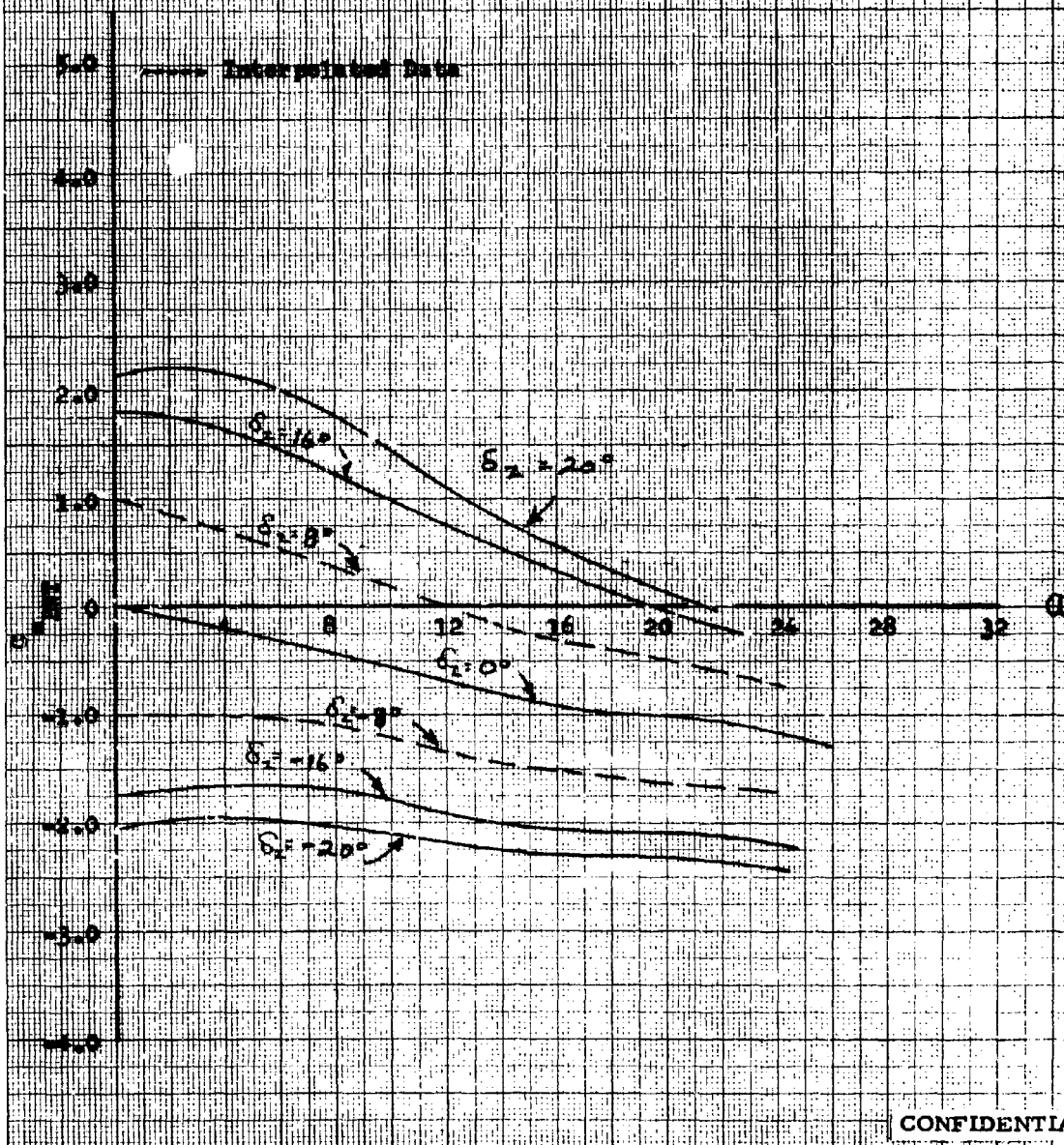


CONFIDENTIAL

CONFIDENTIAL

Fig. 35- Sparrow III Pitching Moment Coefficient

$$C_{m_{\alpha}} \text{ vs } \alpha$$
$$M=1.60 \quad \phi=45^\circ$$



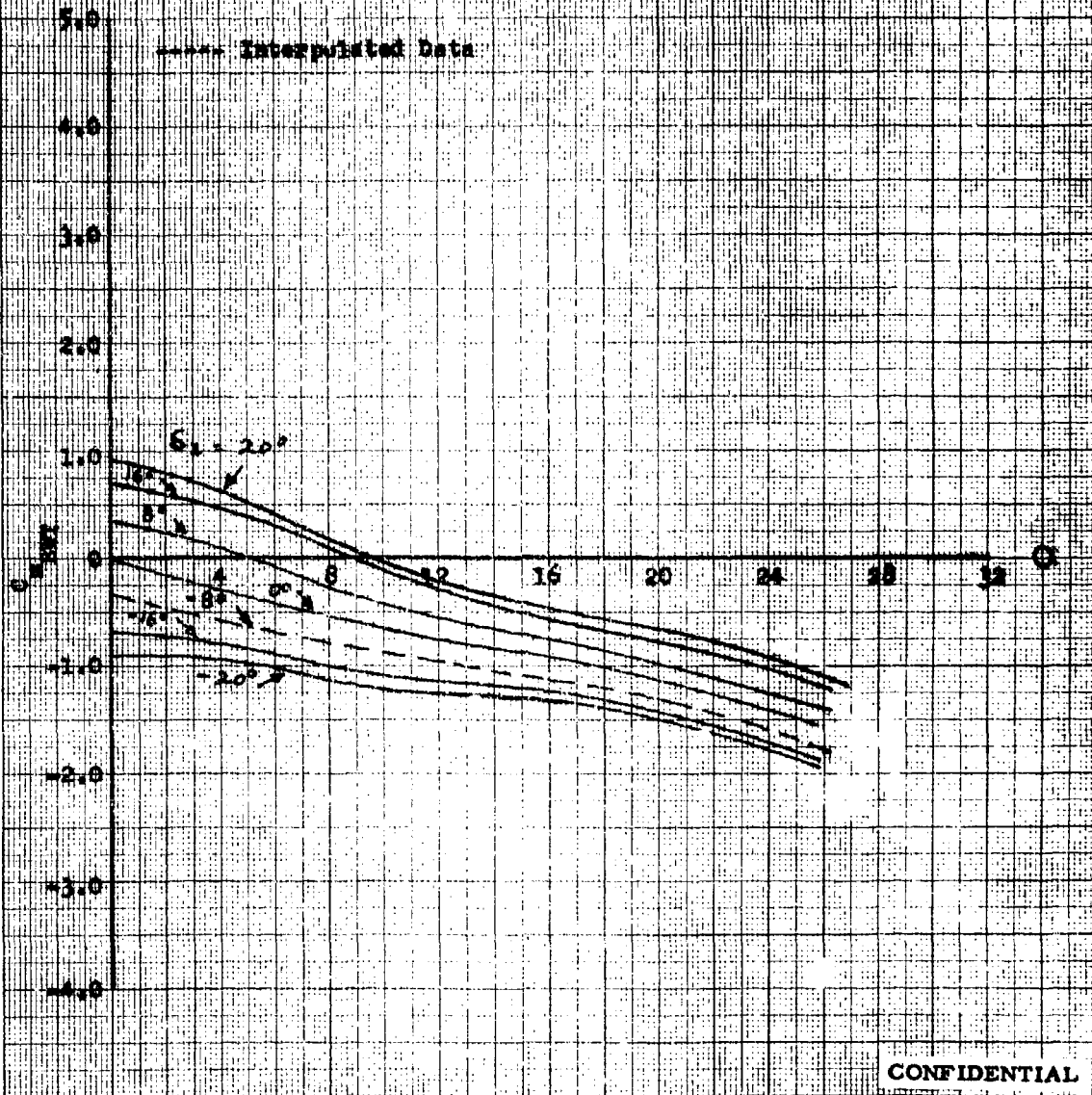
CONFIDENTIAL

CONFIDENTIAL

Fig. 40- Sparrow III Pitching Moment Coefficient

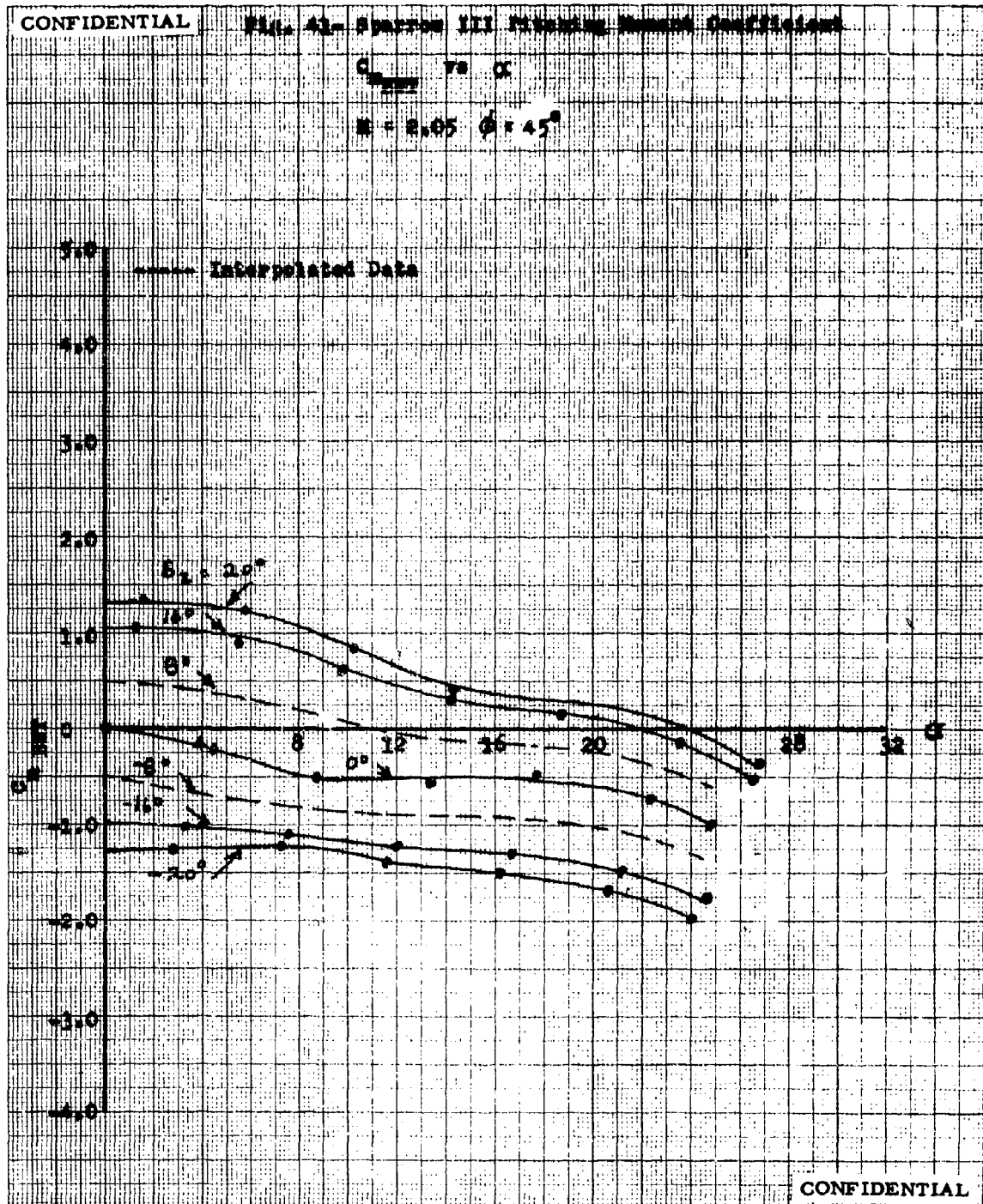
$C_{m, \text{BET}}$ vs α

$M = 2.05$ $\phi = 0^\circ$



CODEE BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS 200 BY 150 DIVISIONS.

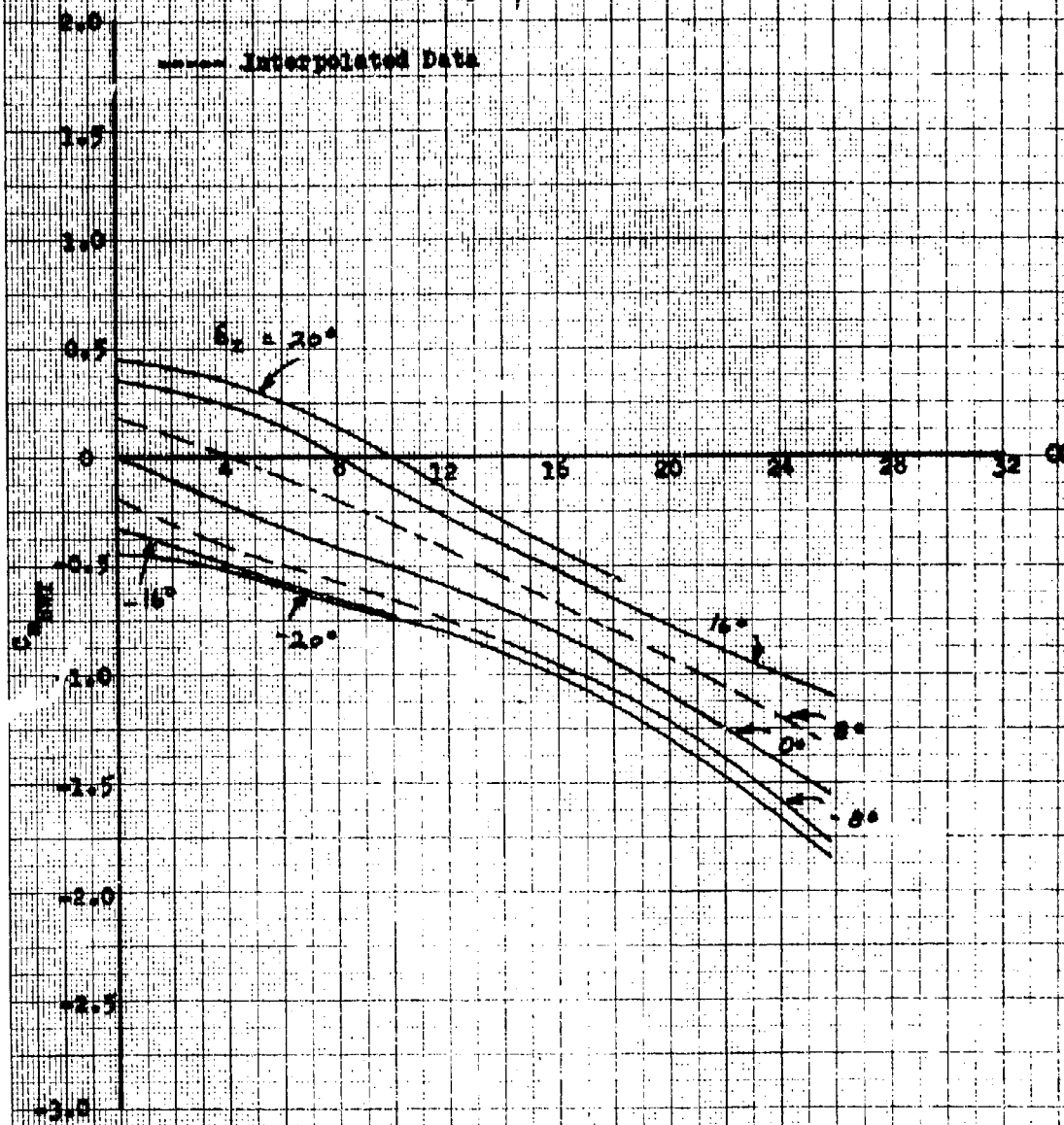


CONFIDENTIAL

Fig. 42. Sparrow III Pitching Moment Coefficient

$$C_{m_{\text{pitch}}} \text{ vs } \alpha$$

$$M = 2.58 \quad \phi = 0^\circ$$



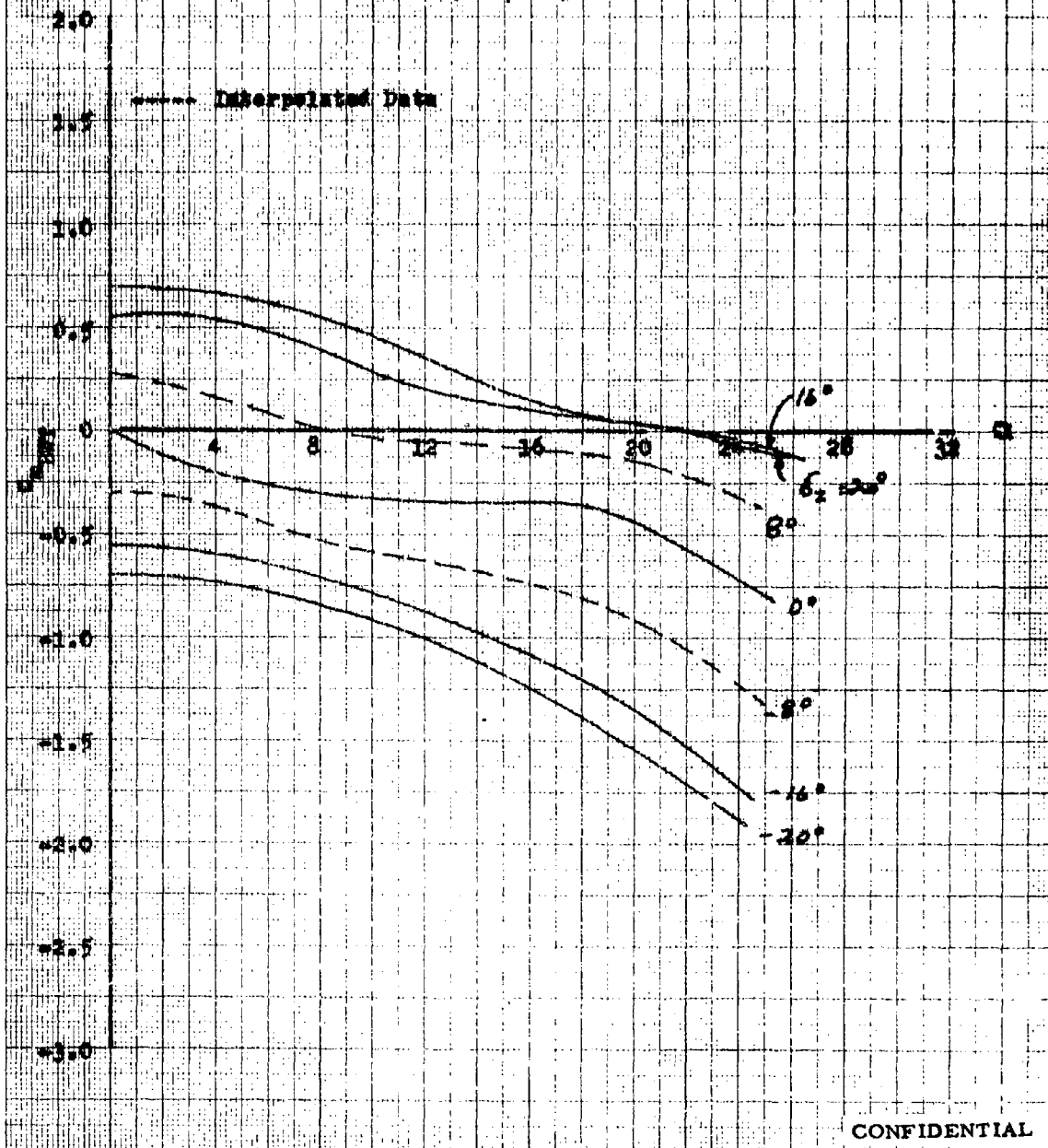
CONFIDENTIAL

CONFIDENTIAL

Fig. 43- Sparrow III Pitching Moment Coefficient

$$C_{m_{DVI}} \text{ vs } \alpha$$

$$M = 2.52 \quad \phi = 45^\circ$$



CODE: ECK COMPANY INC., NORWOOD, MASSACHUSETTS
REVISED 1-54

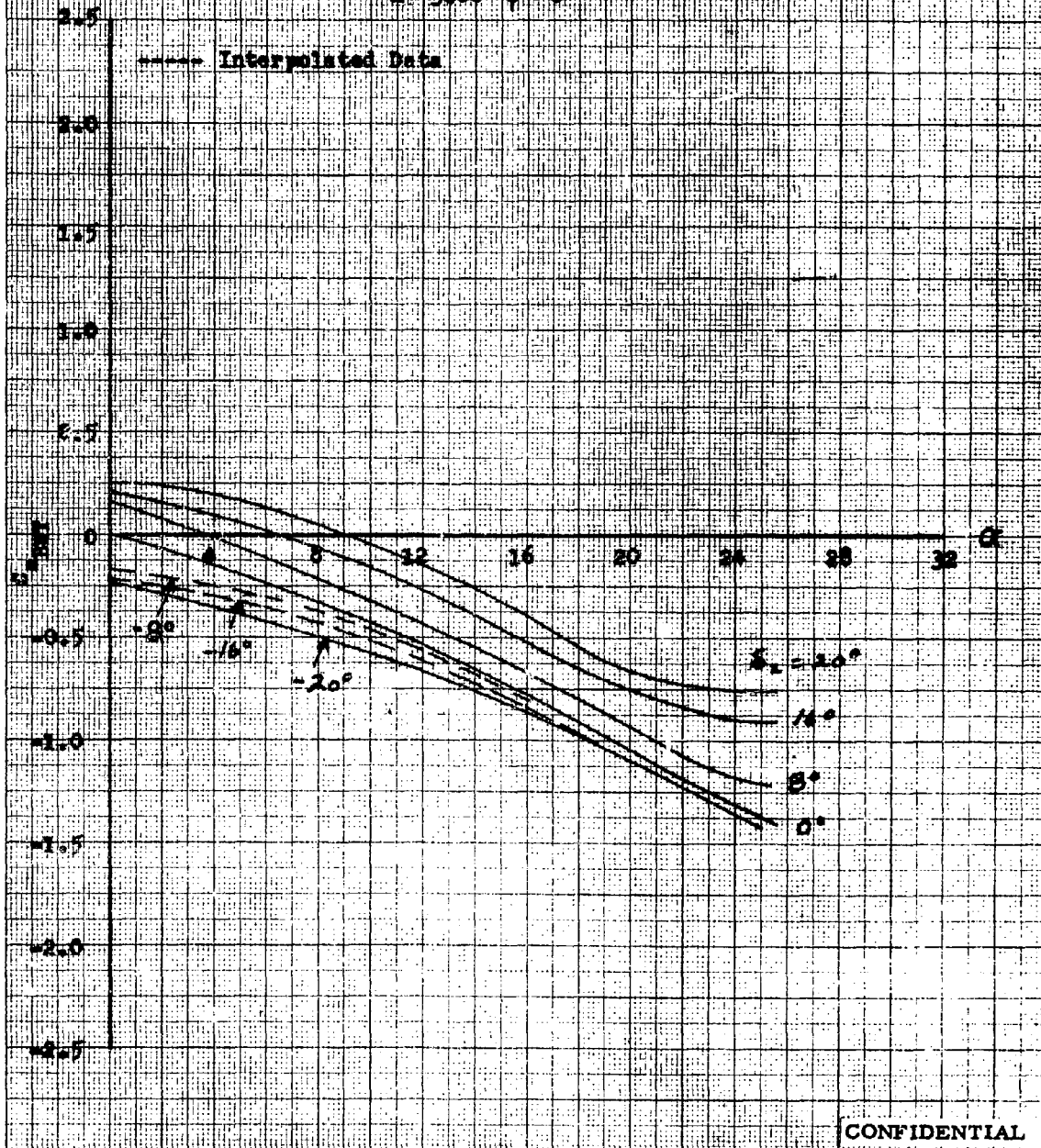
NO. 318A. MILLIMETERS 250 BY 250 DIVISIONS

CONFIDENTIAL

CONFIDENTIAL

Fig. 44- Sparrow III Pitching Moment Coefficient

$C_{m_{sp}} \text{ vs } \alpha$
 $M=3.06 \quad \phi=0^\circ$

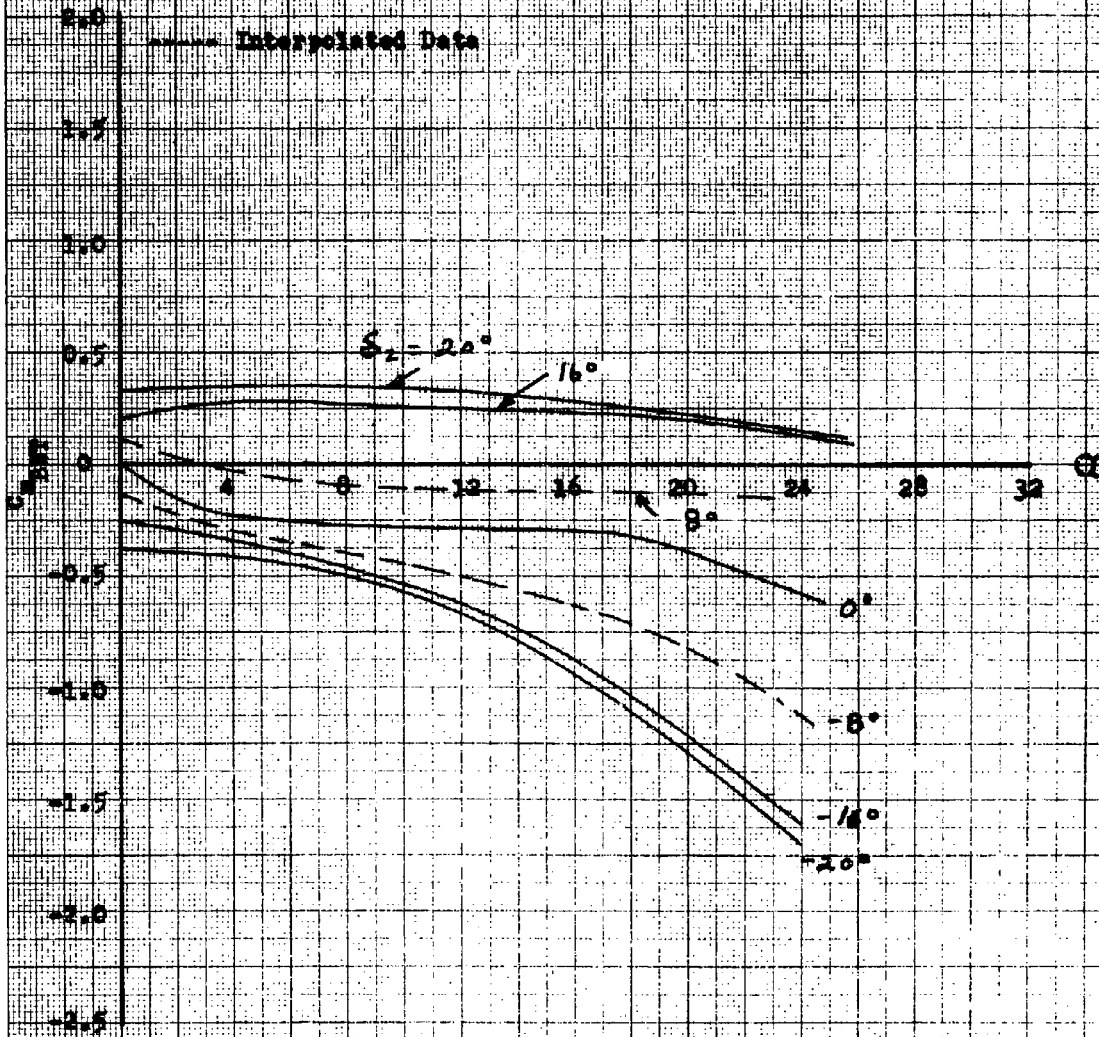


CONFIDENTIAL

Fig. 45- STAFFORD III Pitching Moment Coefficient

$$C_{M_{PWT}} \text{ vs } \alpha$$

$$M = 3.06 \quad \phi = 45^\circ$$



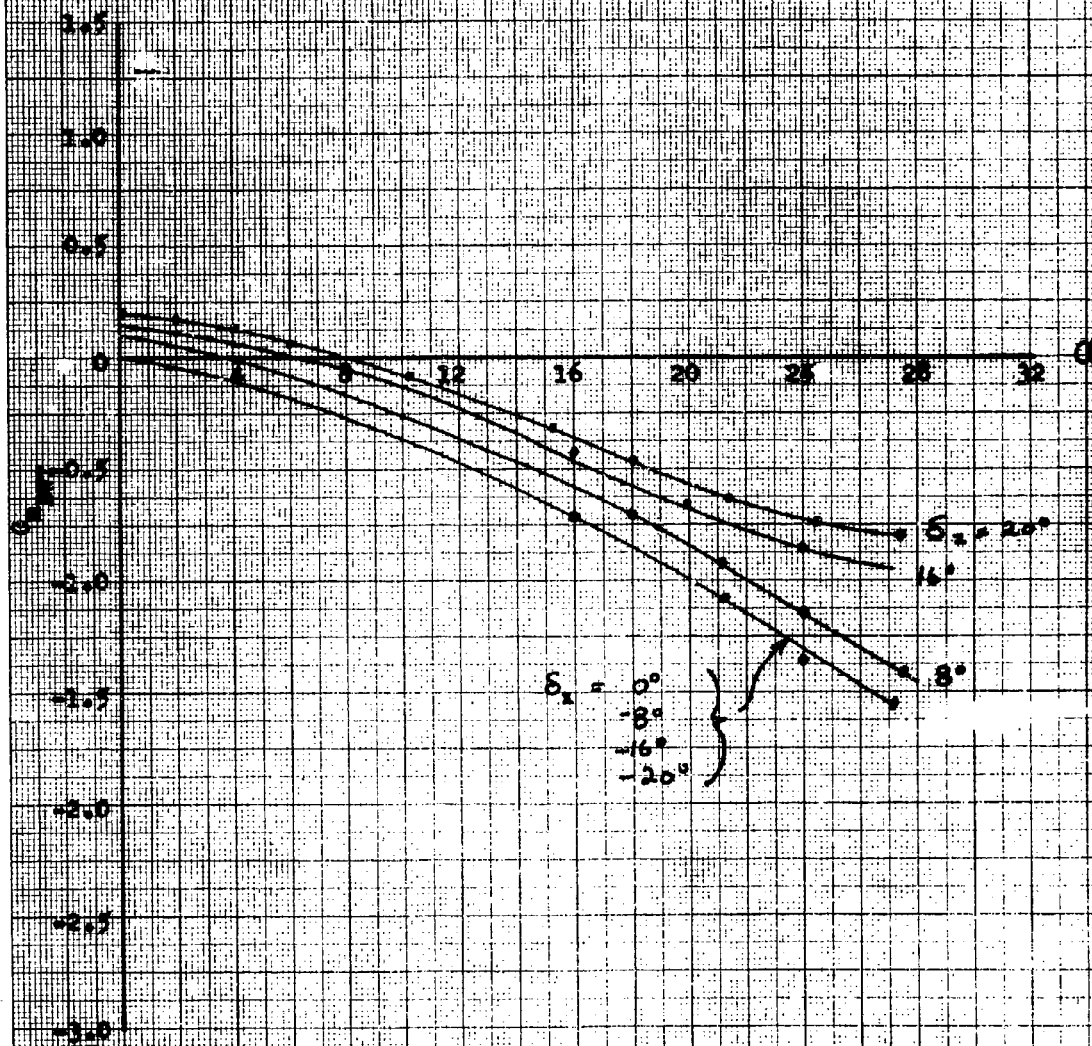
CONFIDENTIAL

CONFIDENTIAL

Fig. 45 Sparrow III Pitching Moment Coefficient

$$C_{m, DAT} \text{ vs } \alpha$$

$$M = 1.49 \quad \phi = 0^\circ$$



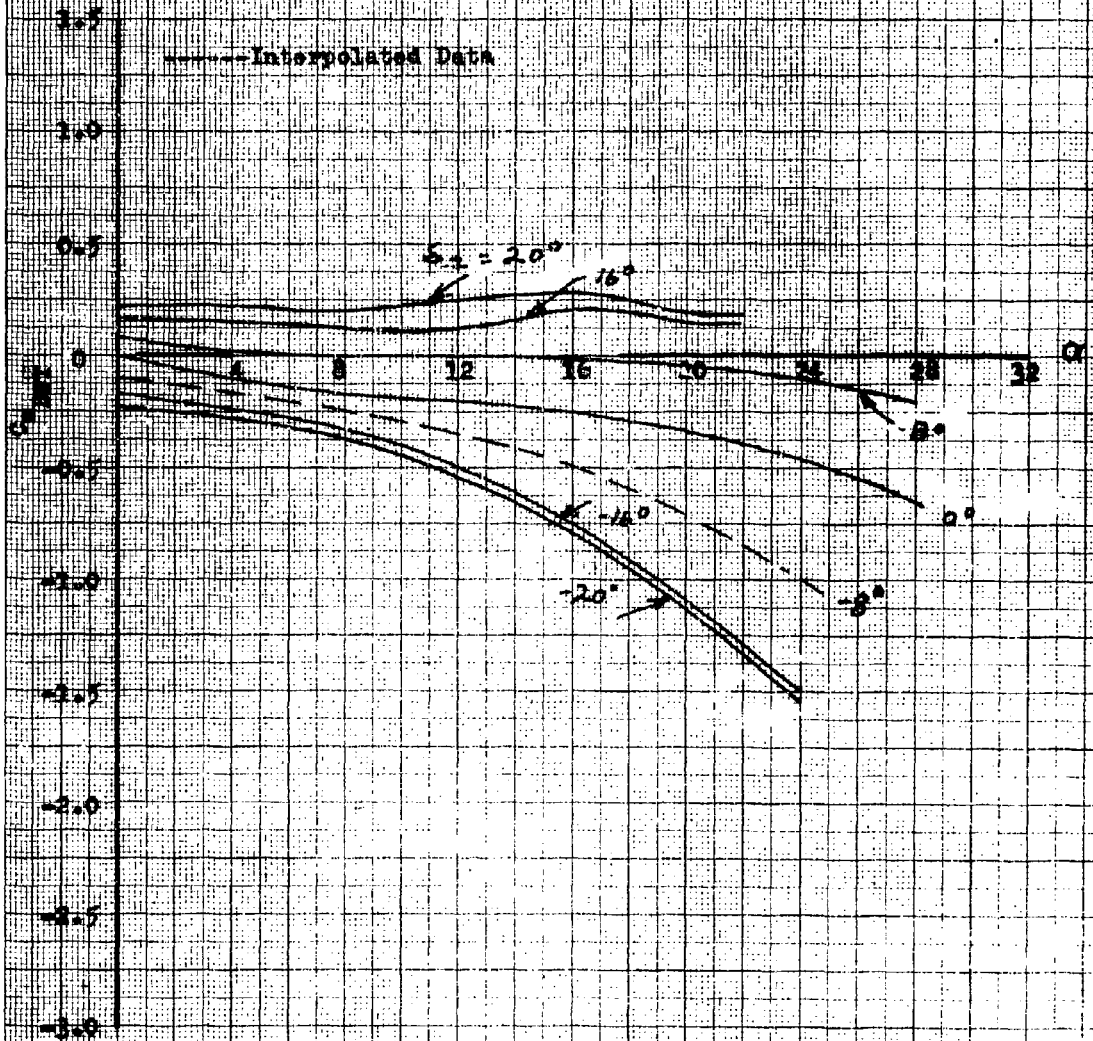
CONFIDENTIAL

CONFIDENTIAL

Fig. 87- Sparrow III Pitching Moment Coefficient

$C_{m_{EWT}}$ vs α

$M = 3.49 \quad \phi = 45^\circ$



CODEX BOOK COMPANY, INC., FORDWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS 200 BY 250 DIVISIONS.

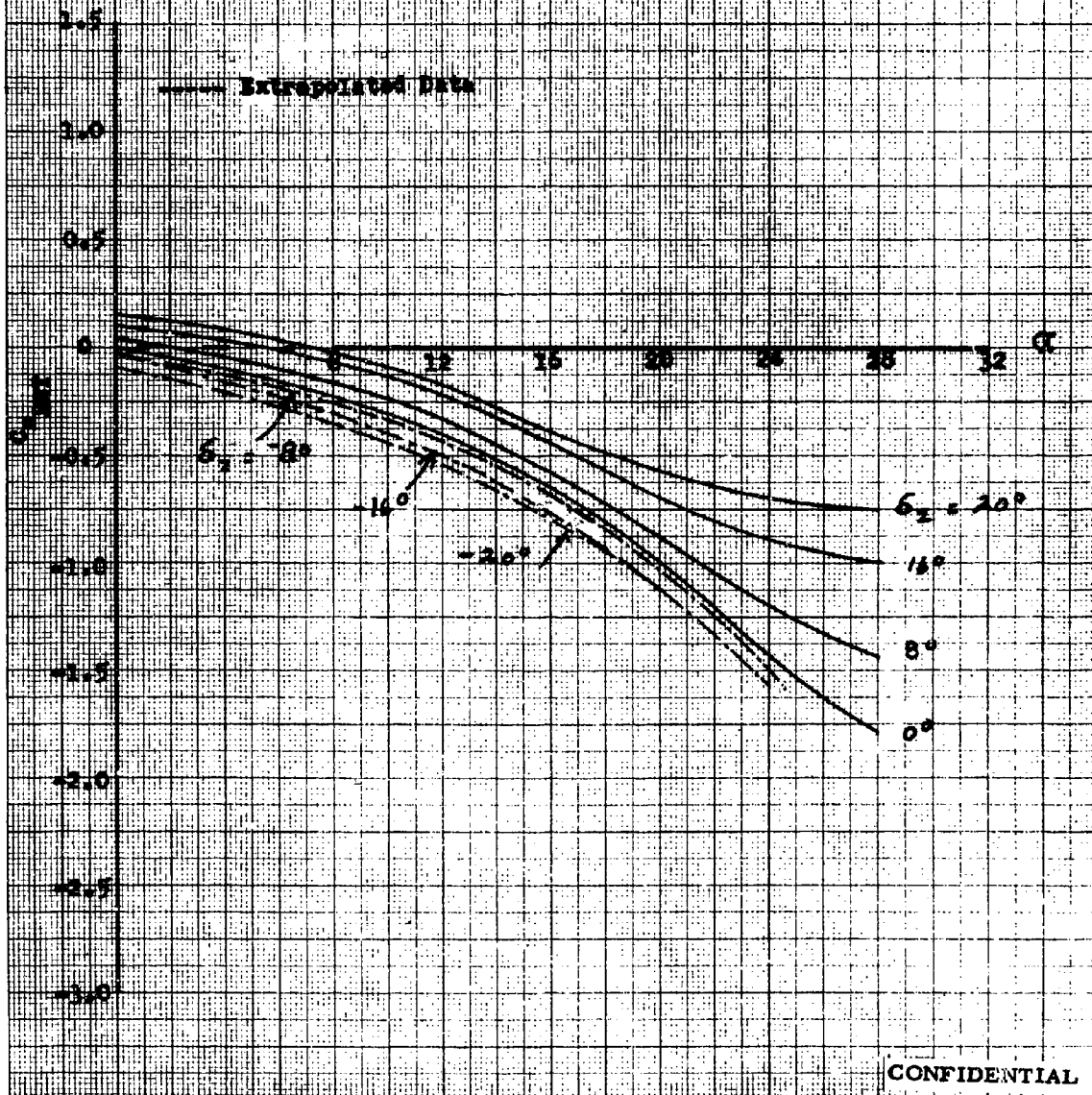
CONFIDENTIAL

CONFIDENTIAL

Fig. 43. Sparrow III Pitching Moment Coefficient

$$C_{m_{\text{ENT}}} \text{ vs } \alpha$$

$$k = 3.96 \quad \phi = 0^\circ$$



CONFIDENTIAL

CONFIDENTIAL

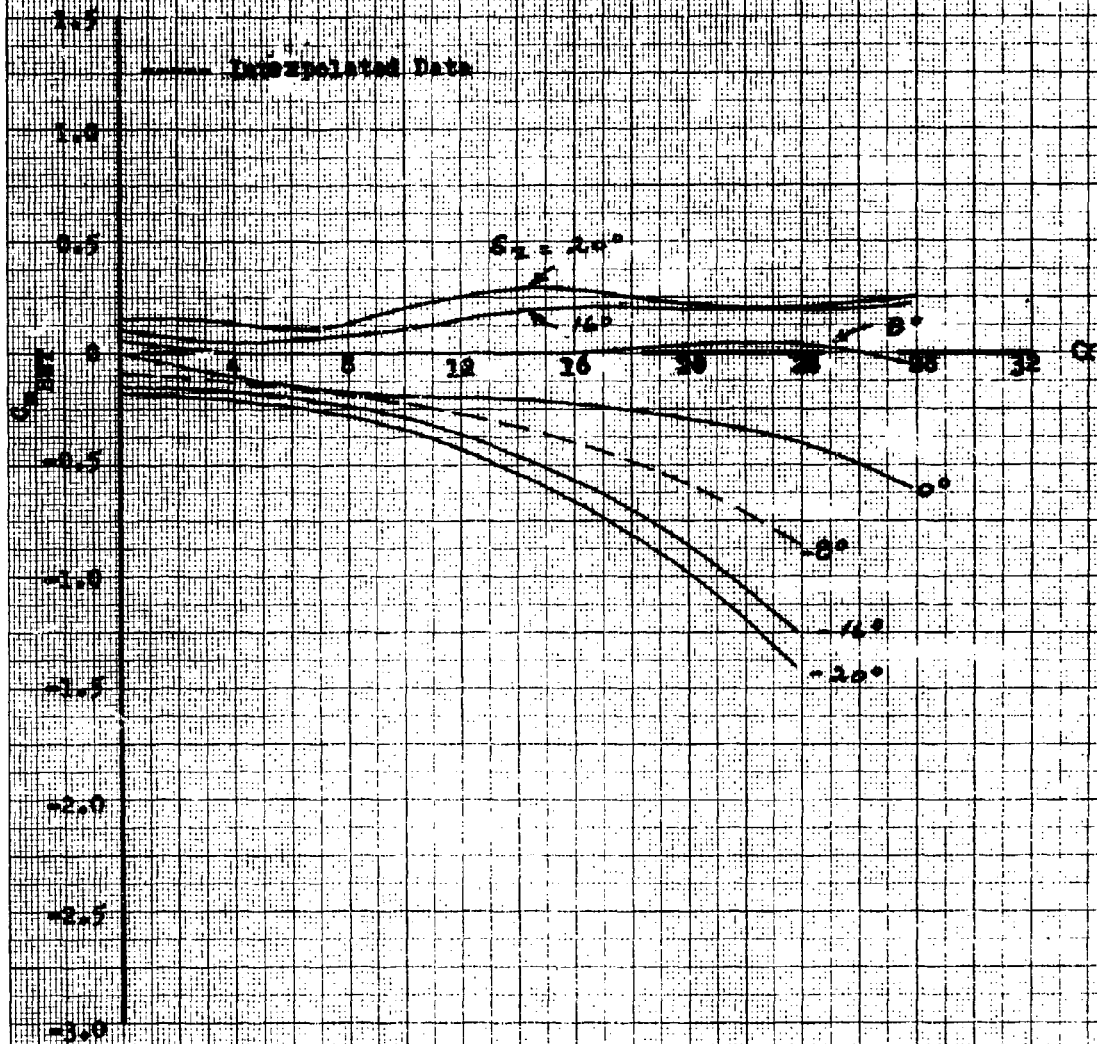
Fig. 42- Sparrow III Pitching Moment Coefficient

$$C_{PM} \text{ vs } \alpha$$

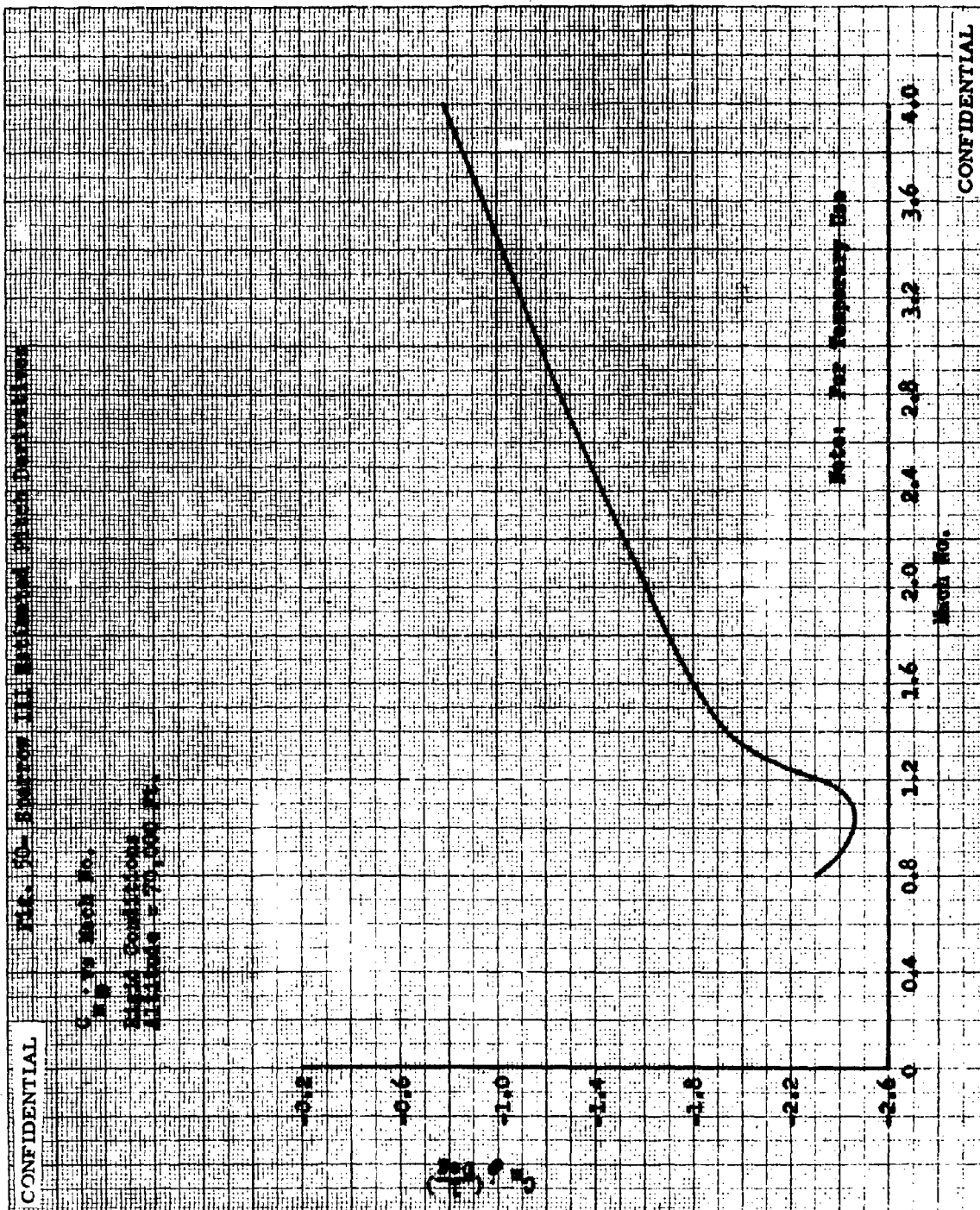
$$K = 2.96 \quad \beta = 15^\circ$$

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS 200 BY 250 DIVISIONS.



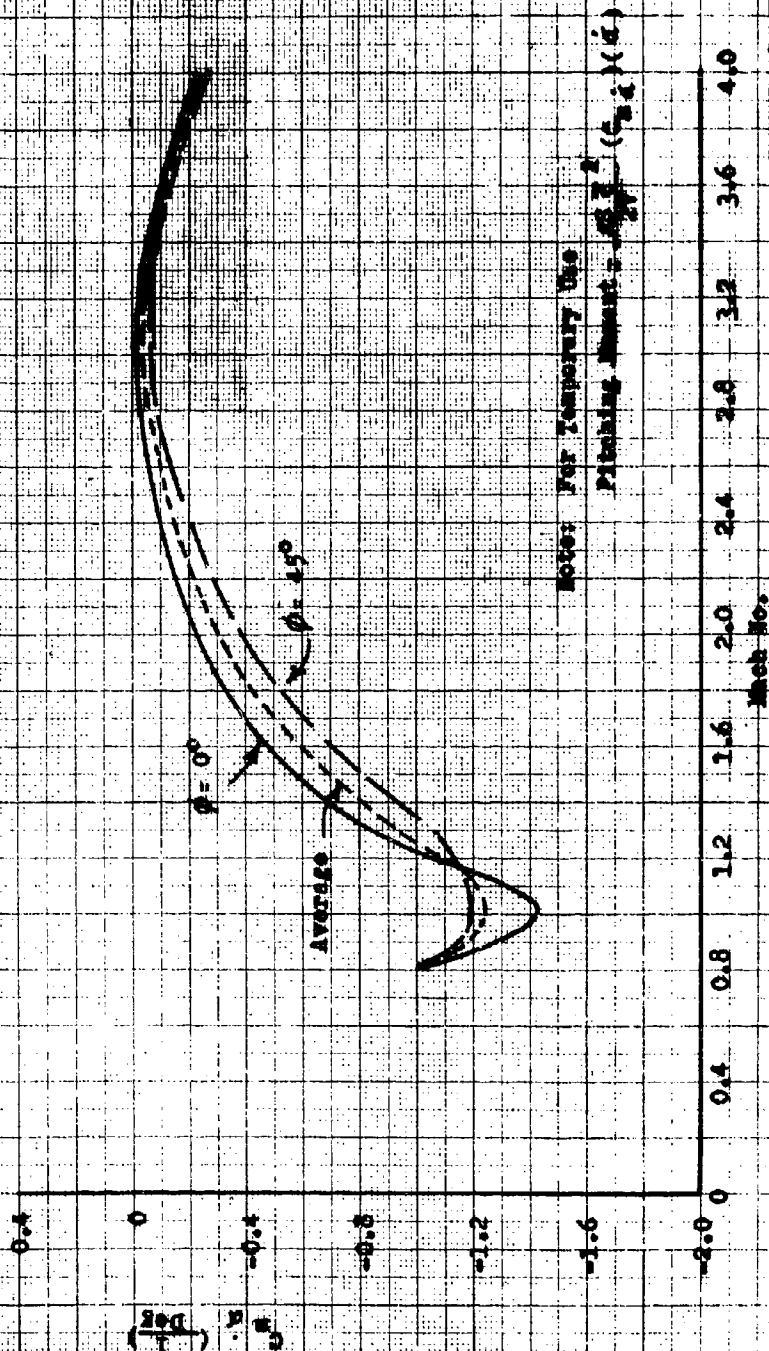
CONFIDENTIAL



CONFIDENTIAL

Fig. 91- Spectrum III Estimated Pitch Derivatives

C_{θ} vs Mach No.
Rigid Conditions
Altitude = 70,000 Ft.

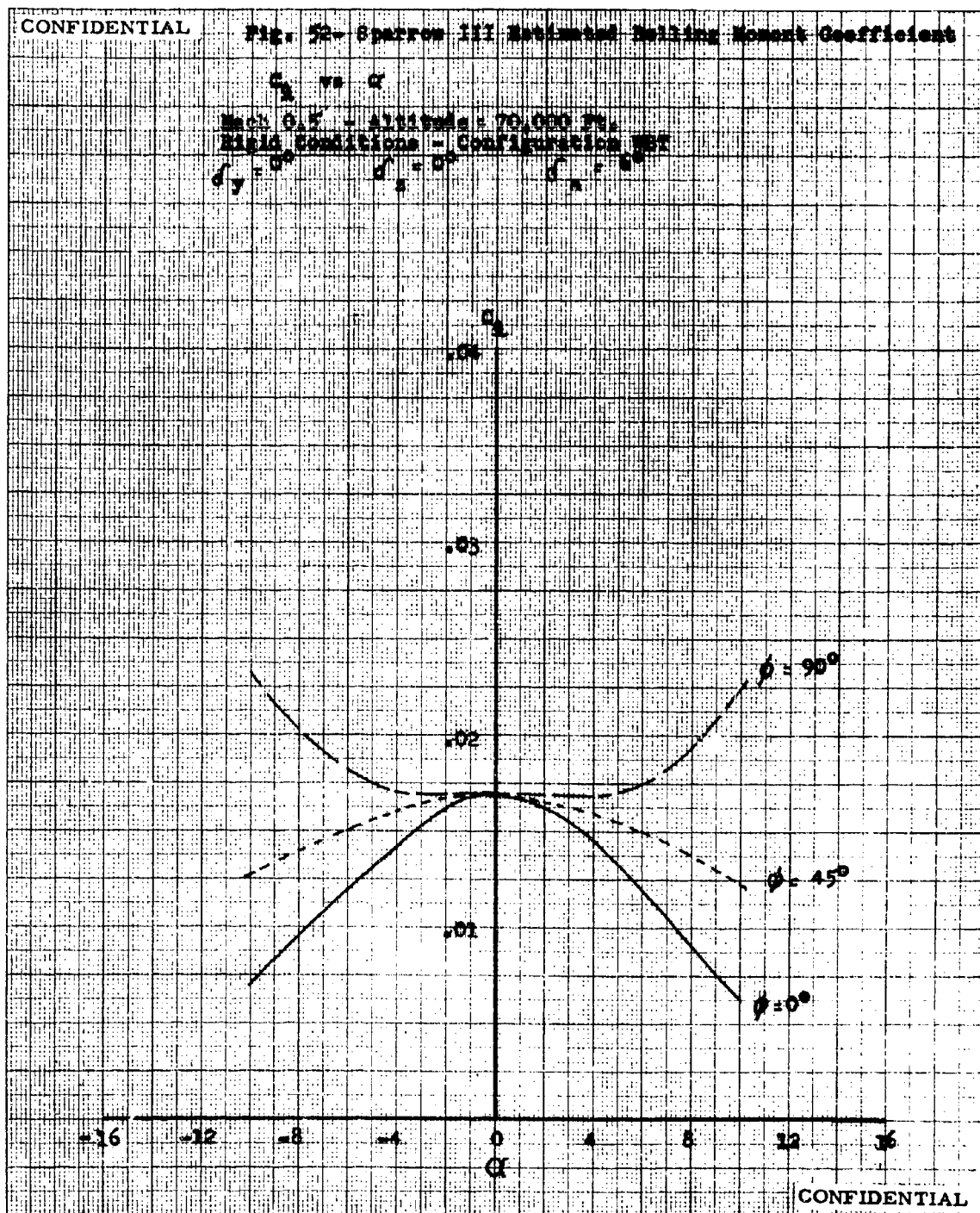


CONFIDENTIAL

CONFIDENTIAL

Fig. 52- Sparrow III Estimated Rolling Moment Coefficient

C_{L_R} vs α
 Mach 0.5 - Altitude = 70,000 ft.
 Rigid Conditions - Configuration 181
 $\delta_y = 0^\circ$ $\delta_z = 0^\circ$



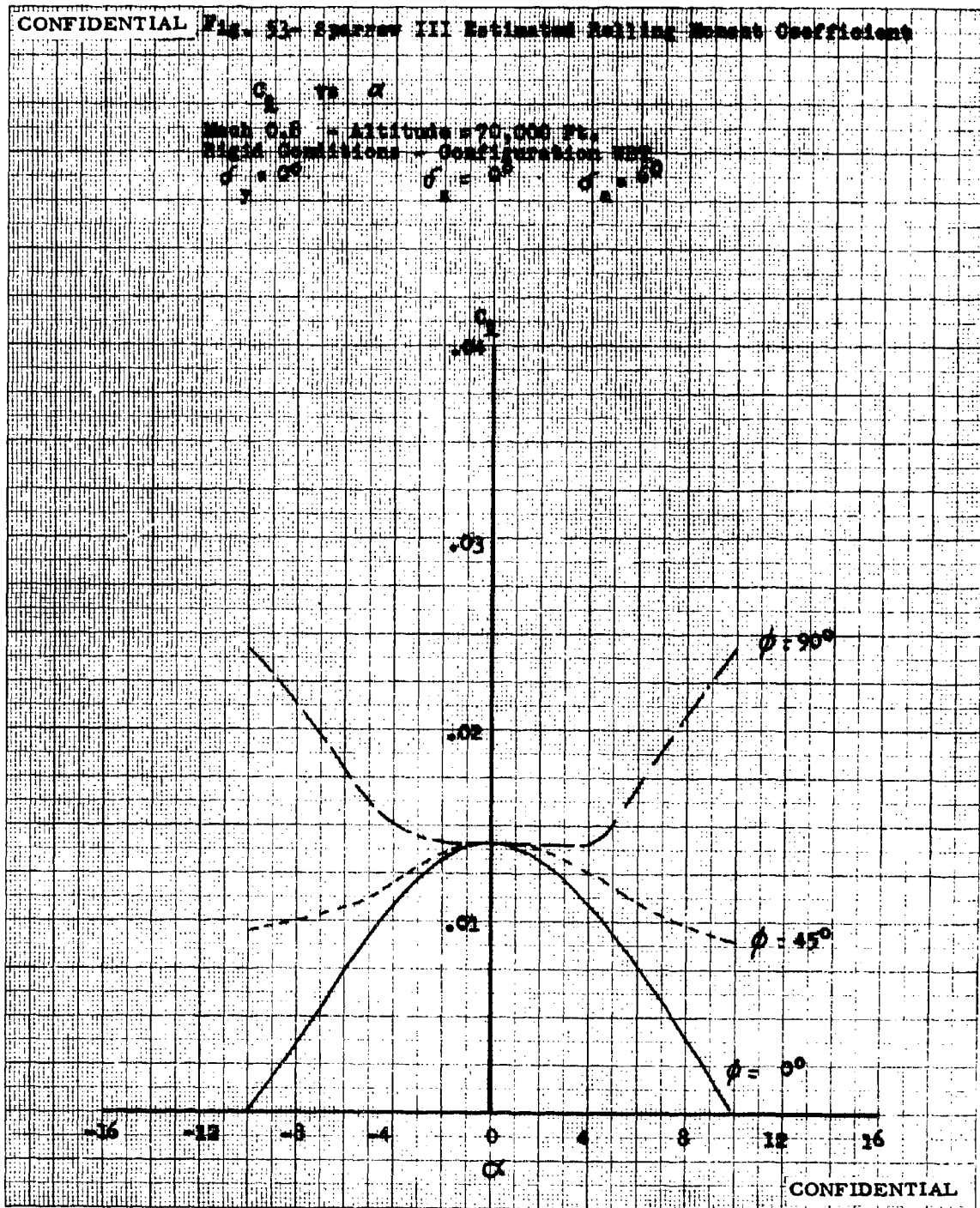
CONFIDENTIAL

CONFIDENTIAL

Fig. 53- Sparrow III Estimated Rolling Moment Coefficient

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

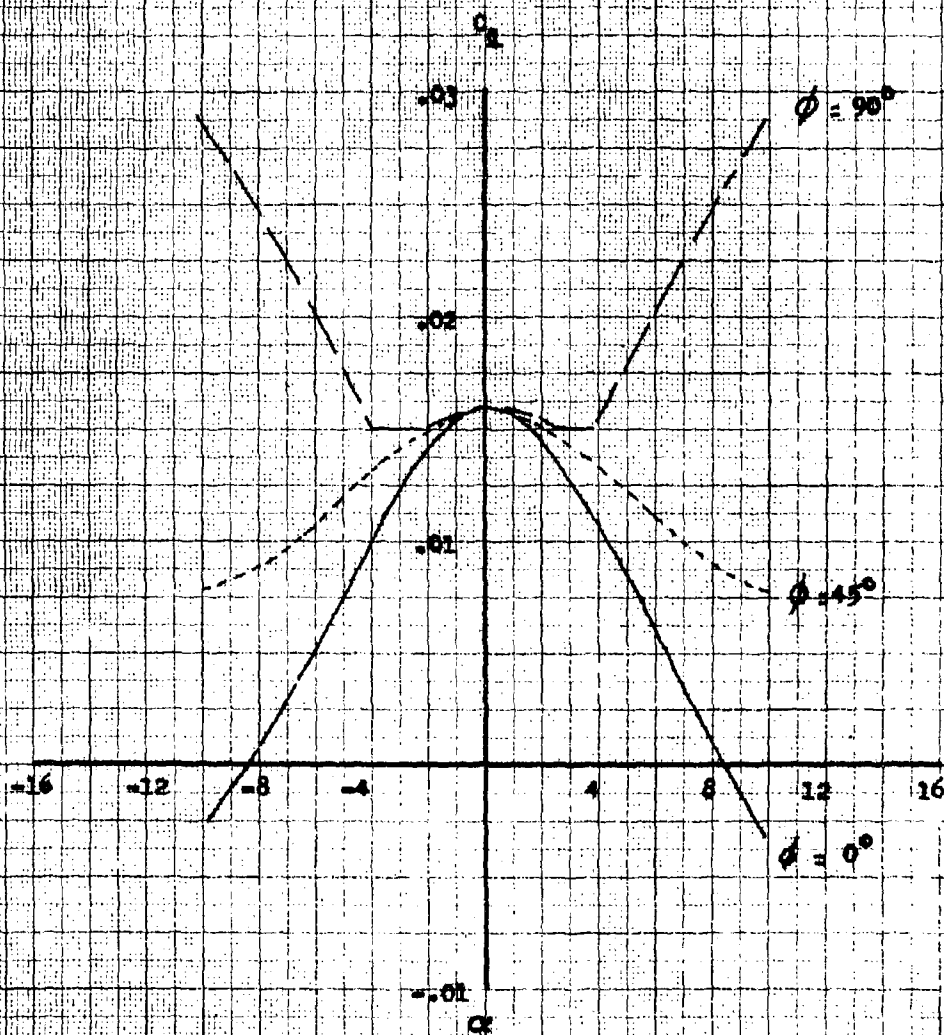
NO. 519A. MILLIMETERS 200 BY 250 DIVISIONS.



CONFIDENTIAL

Fig. 54- Sparrow III Estimated Rolling Moment Coefficient

C_2 vs α
 Mach 0.87 - Altitude - 70,000 Ft.
 Rigid Conditions - Configuration B21
 $\delta_y = 0^\circ$ $\delta_z = 0^\circ$ $\delta_x = 0^\circ$



CONFIDENTIAL

CONFIDENTIAL Fig. 55- Sparrow III Estimated Rolling Moment Coefficient

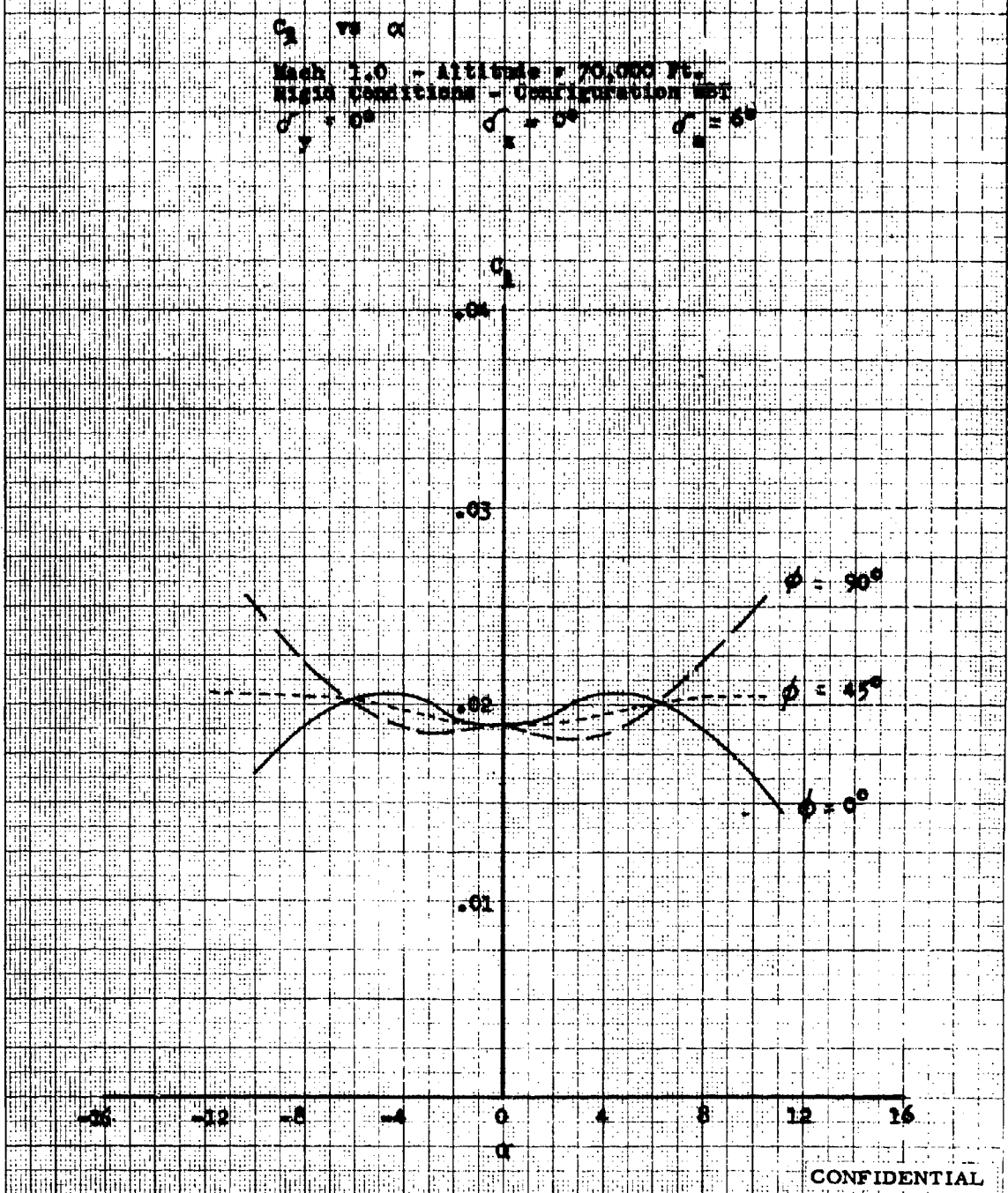
C_L vs α

Mach 1.0 - Altitude = 70,000 Ft.
High Conditions - Configuration 101

$\phi = 0^\circ$ $\phi = 45^\circ$ $\phi = 90^\circ$

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS 200 BY 250 DIVISIONS.



CONFIDENTIAL

CONFIDENTIAL

Fig. 56- Sparrow III Estimated Rolling Moment Coefficient

C_L vs α

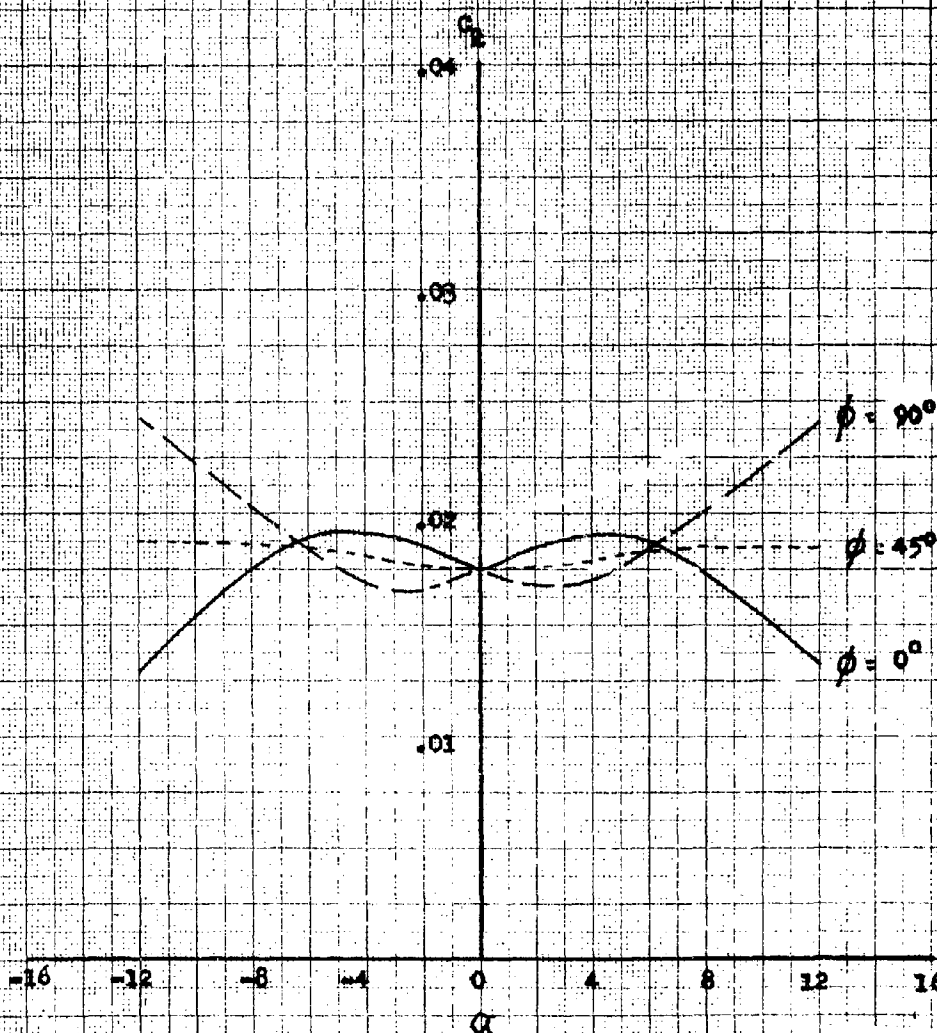
Mach 1.1 - Altitude - 70,000 Ft.

Rigid Conditions - Configuration WBT

$\phi = 0^\circ$

$\phi = 0^\circ$

$\phi = 0^\circ$



CONFIDENTIAL

CONFIDENTIAL

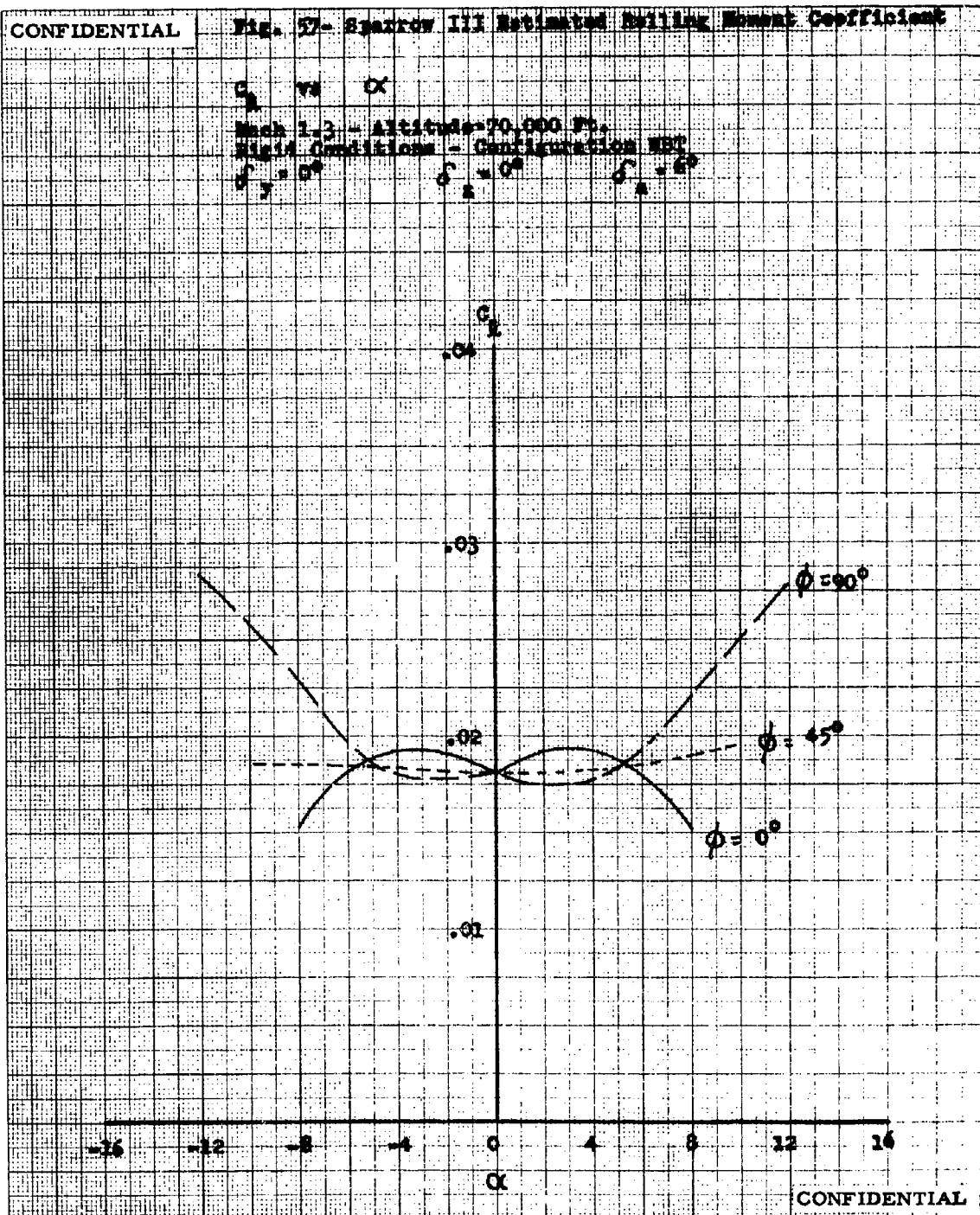
Fig. 57- Sparrow III Estimated Rolling Moment Coefficient

C_{L_R} vs α

Mach 1.3 - Altitude 70,000 Ft.
Rigid Conditions - Configuration NBT
 $\delta_1 = 0^\circ$ $\delta_2 = 0^\circ$ $\delta_3 = 6^\circ$

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS 200 BY 250 DIVISIONS

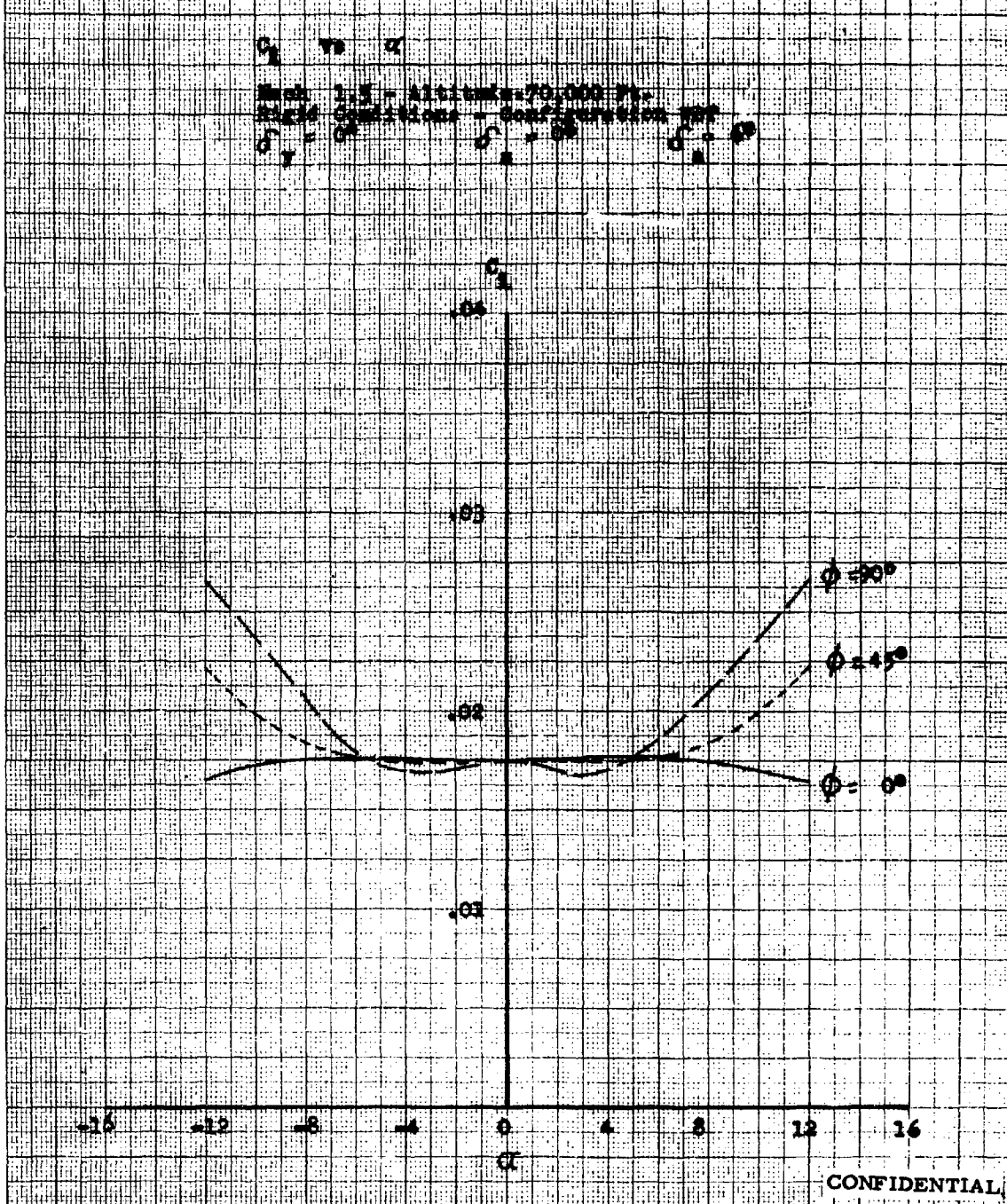


CONFIDENTIAL

CONFIDENTIAL

Fig. 58- Sparrow III Estimated Rolling Moment Coefficient

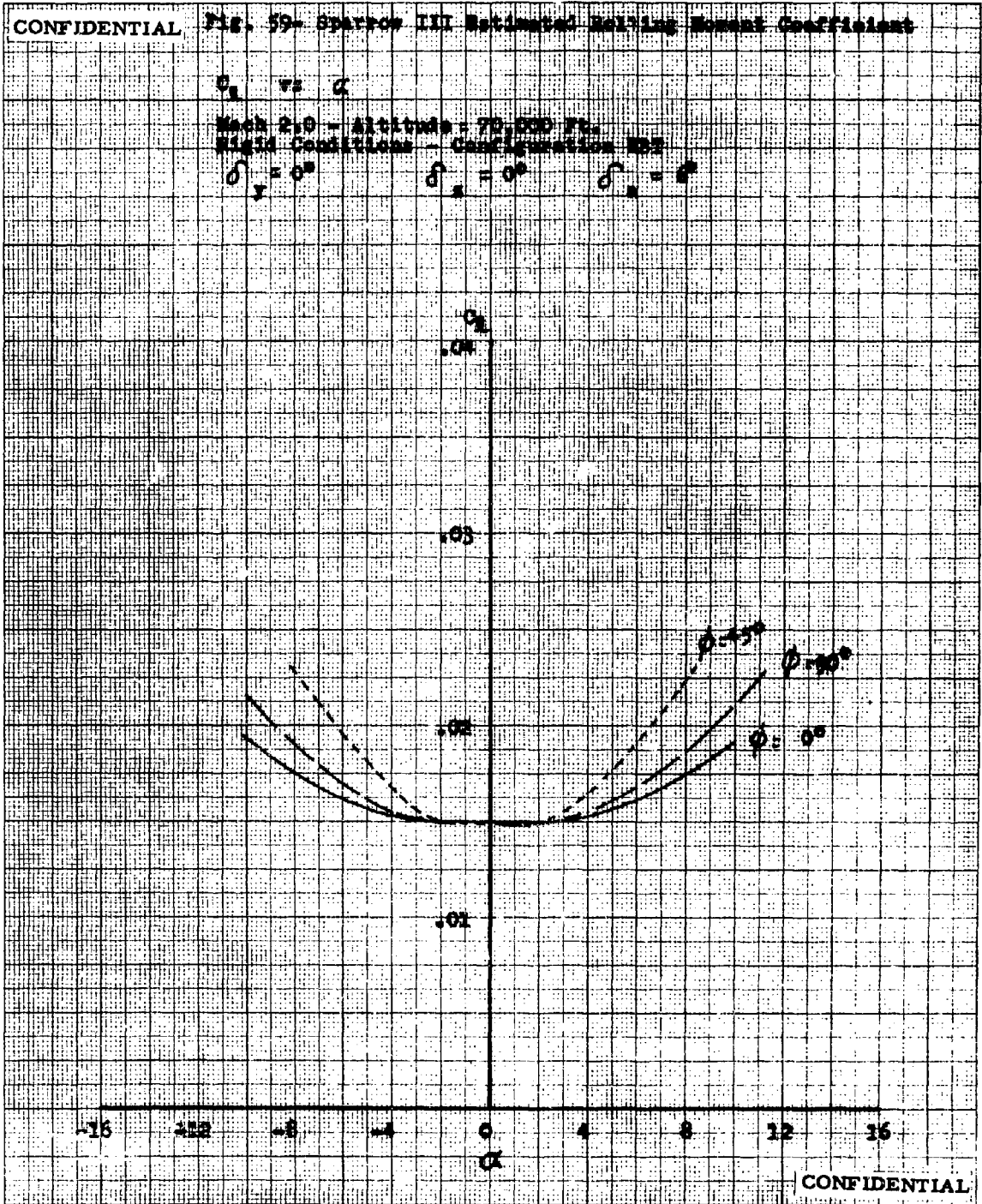
C_{L} vs α
 Mach 1.5 - Altitude 70,000 ft.
 Model Configuration - Configuration 100



CONFIDENTIAL

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

NO. 319A. MILLIMETERS. 200 BY 250 DIVISIONS.



CONFIDENTIAL

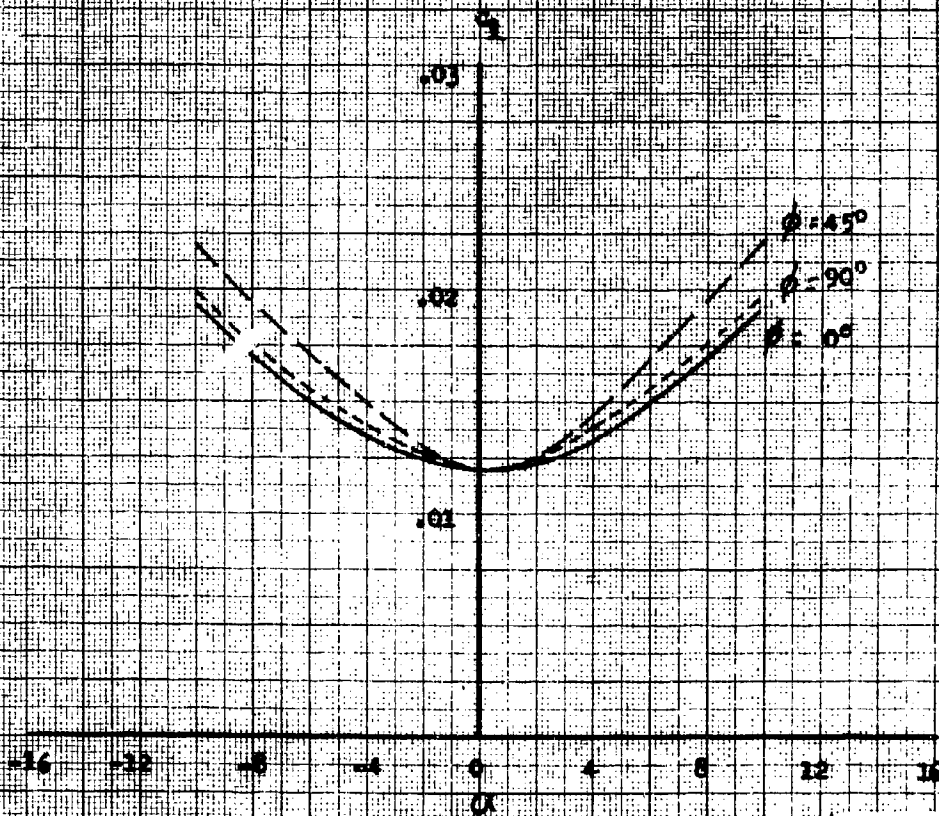
Fig. 50- Sparrow III Estimated Rolling Moment Coefficient

C_L vs α

Wing 2.5 - Altitude - 70,000 Ft.

Flight Conditions - Configuration BDT

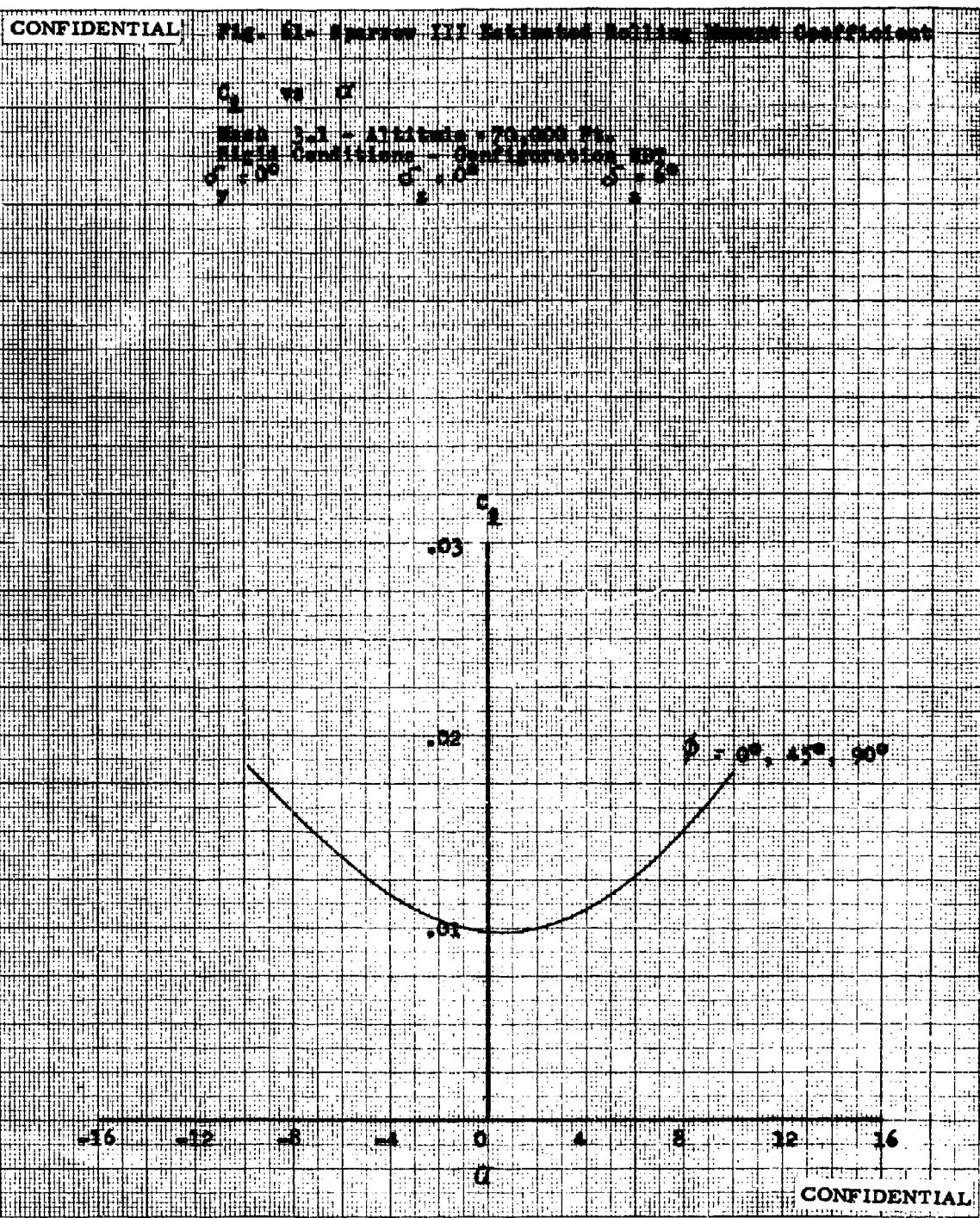
$\delta_y = 0^\circ$ $\delta_x = 0^\circ$ $\delta_z = 0^\circ$



CONFIDENTIAL

CODER BOOK COMPANY, INC., BOSTON, MASSACHUSETTS.
PRINTED IN U.S.A.

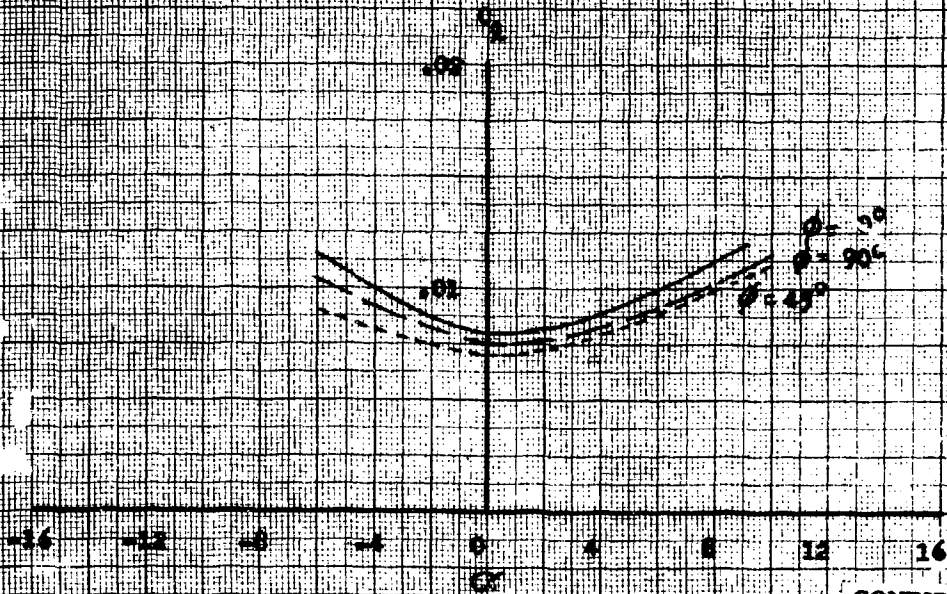
NO. 319A. MILLIMETERS 200 BY 230 DIVISIONS.



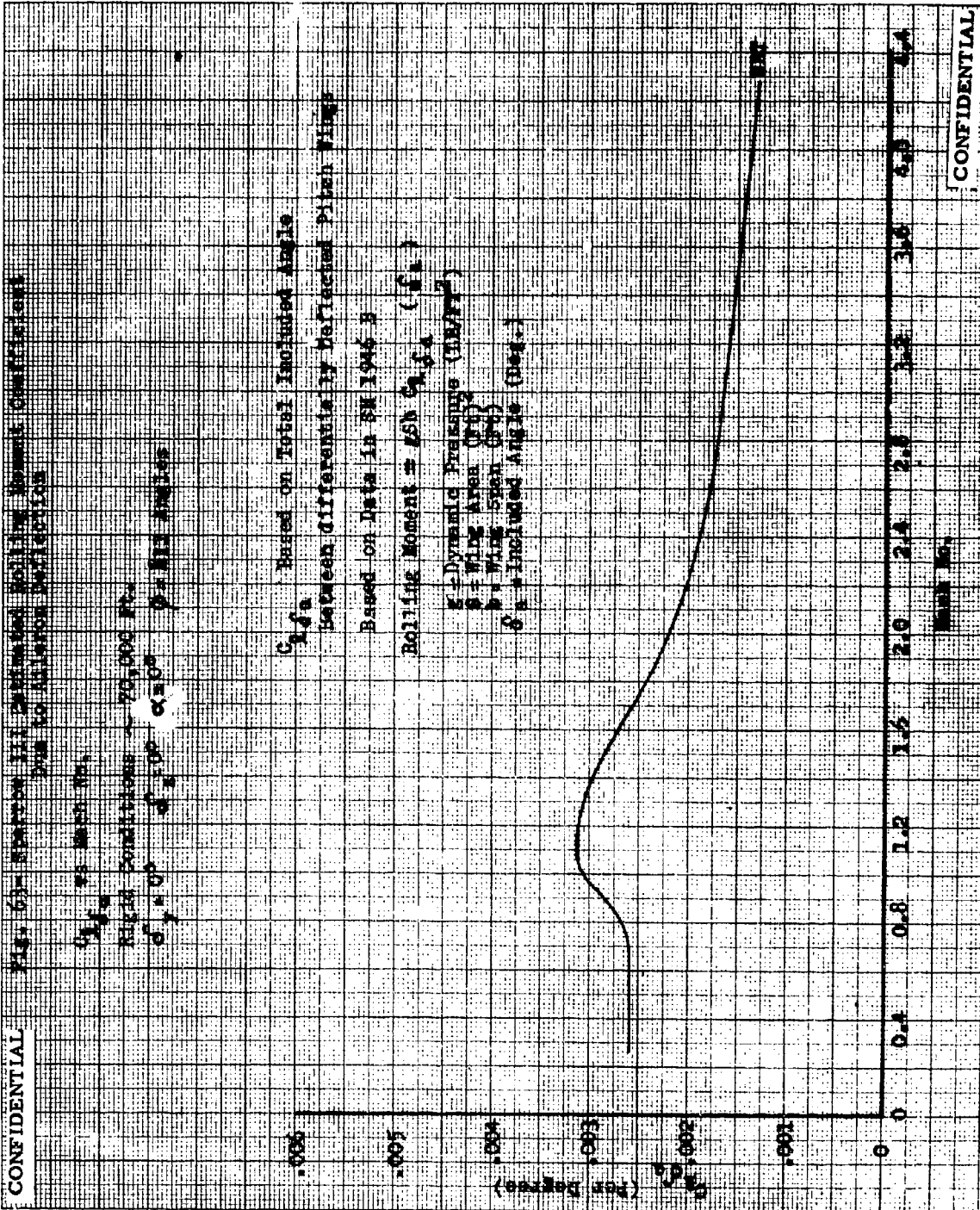
CONFIDENTIAL

Fig. 22 - Graph of the Ballistic Coefficient

Ball. Coeff. - 10.000 lb.
Ball. Coeff. - 10.000 lb.



CONFIDENTIAL



CONFIDENTIAL

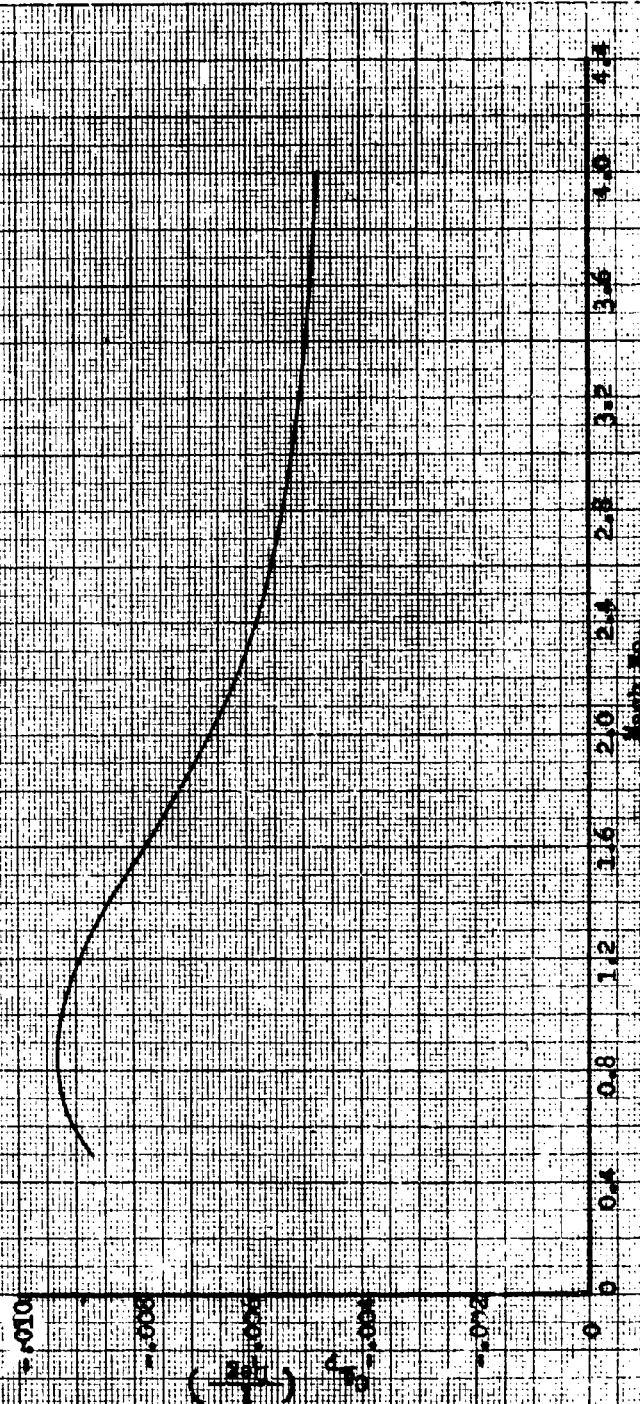
Fig. 50. Spectrum III Estimated Roll Resonant Damping Coefficient

δ_r vs Mach No.

Configuration VII

$$\delta_r = \frac{\delta \left(\frac{p}{2V} \right)}{\delta \left(\frac{p}{2V} \right)}$$

Roll Damping Coefficient = $\frac{80V}{2V}$

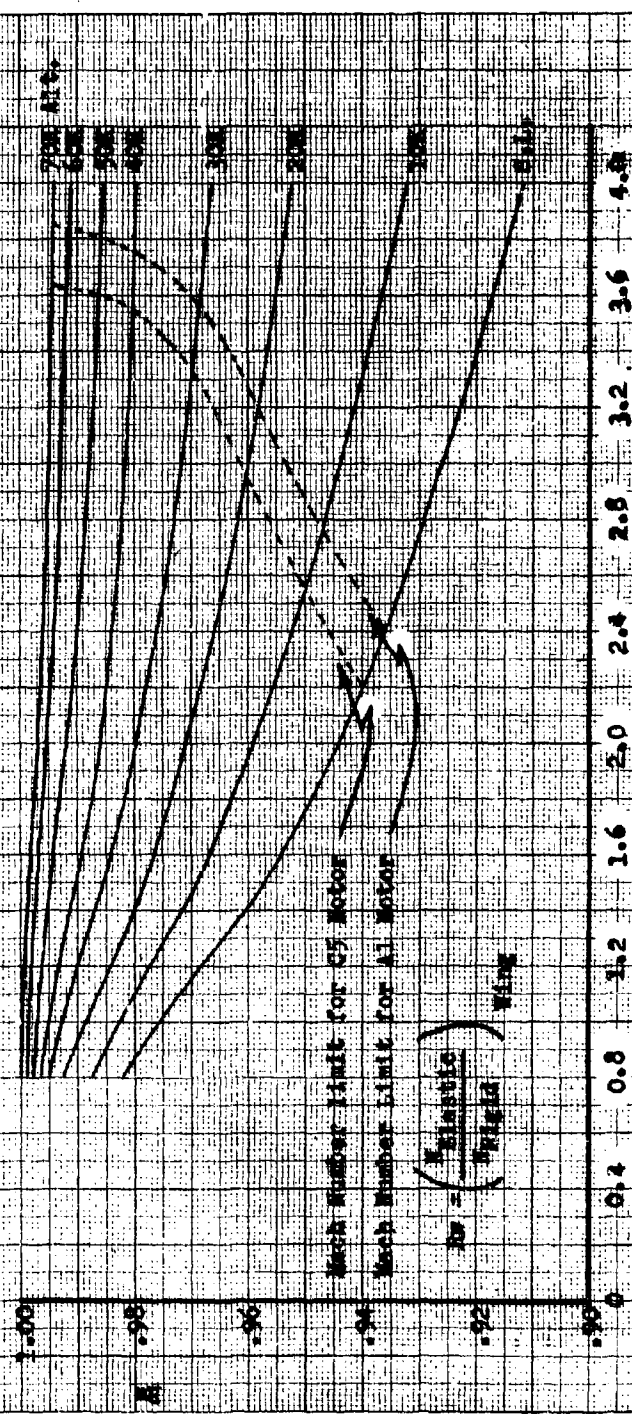


CONFIDENTIAL

CONFIDENTIAL

Fig. 85. SYSTEM III WING Aerodynamic Characteristics

Wing No.

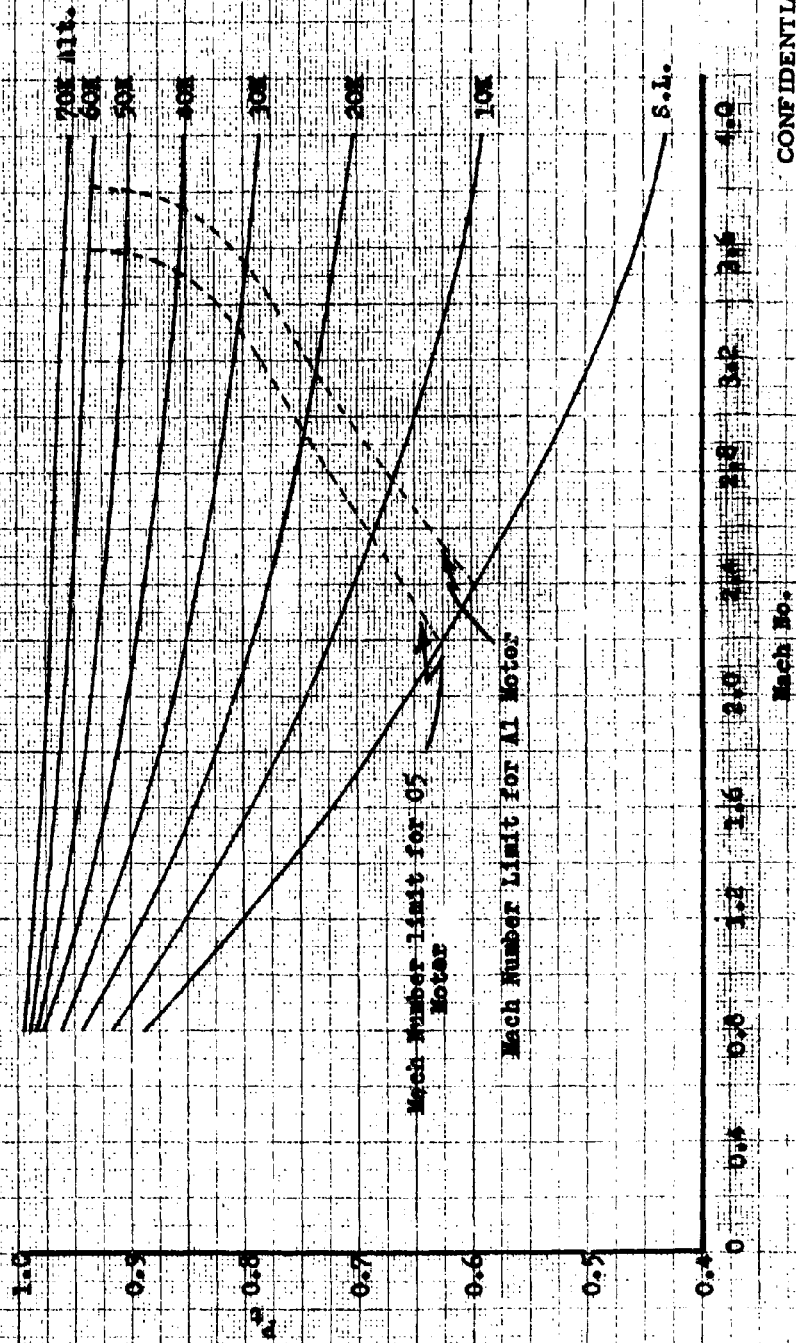


CONFIDENTIAL

CONFIDENTIAL

Fig. 66- Sparrow III Tail Aerodynamic Correction Factor

P_c Vs Mach No.

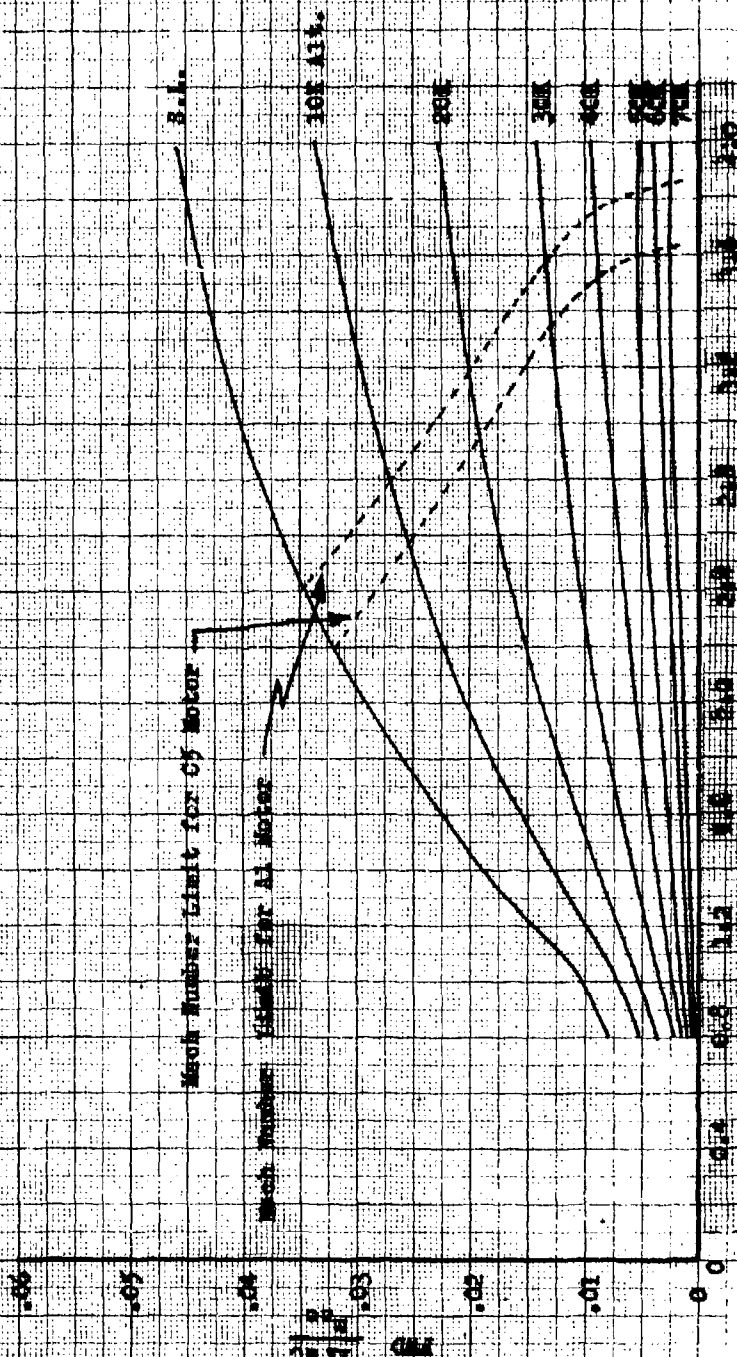


CONFIDENTIAL

CONFIDENTIAL

Fig. 67. Sparrow III Aerodynamic Characteristics Generation Factor

100 vs Mach No.



Mach No.

CONFIDENTIAL

CONFIDENTIAL

Fig. 68 - Typical Thrust/Time Curve

Note:



Fig. 68 - Typical Thrust/Time Curve

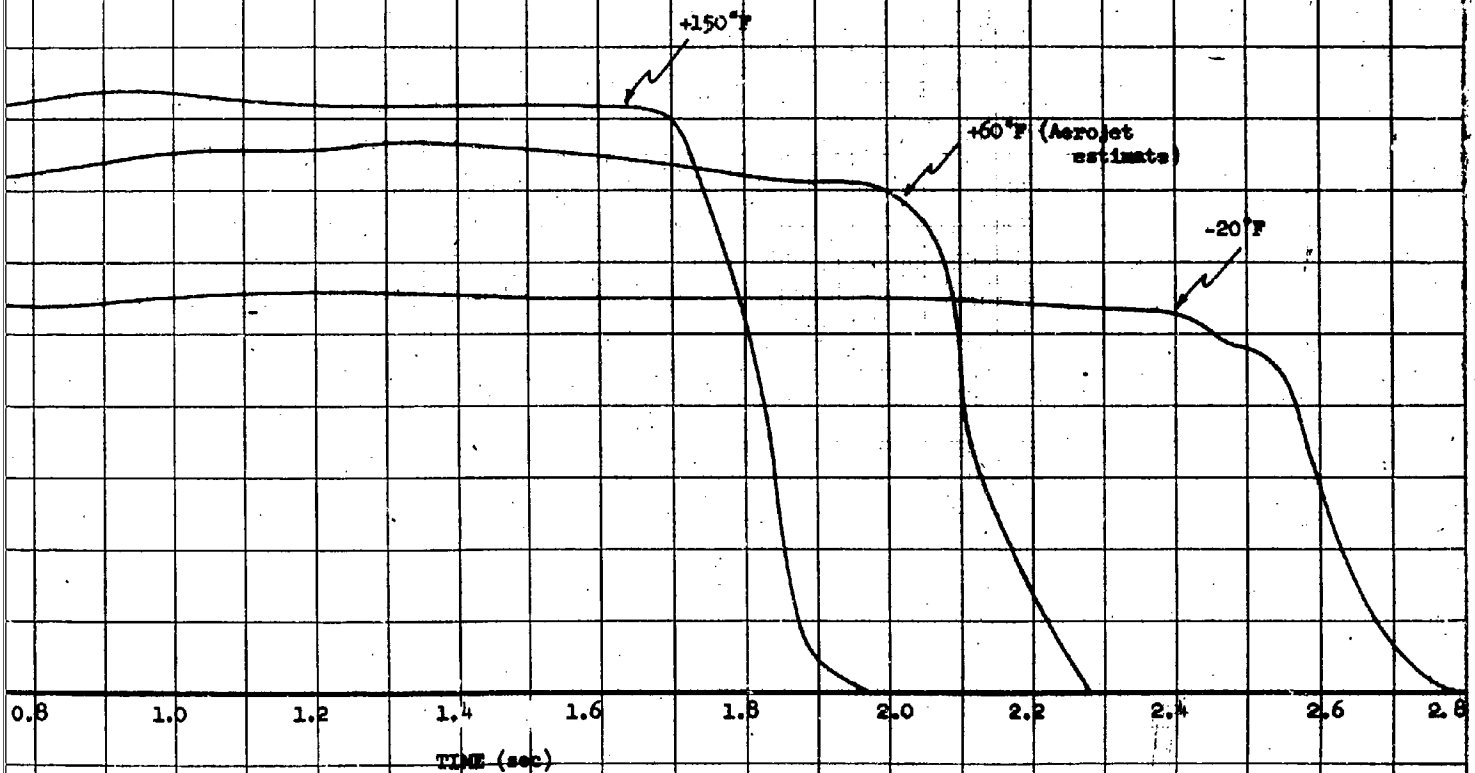
Note: Engines are batch-checked at +150°F and -20°F. The values shown here at these temperatures are from static test data. As noted, the value at 65°F is an Aerojet estimate.

Total impulse for these curves:

-20°F = 13,372 lbs/sec

+60°F = 14,560 lbs/sec

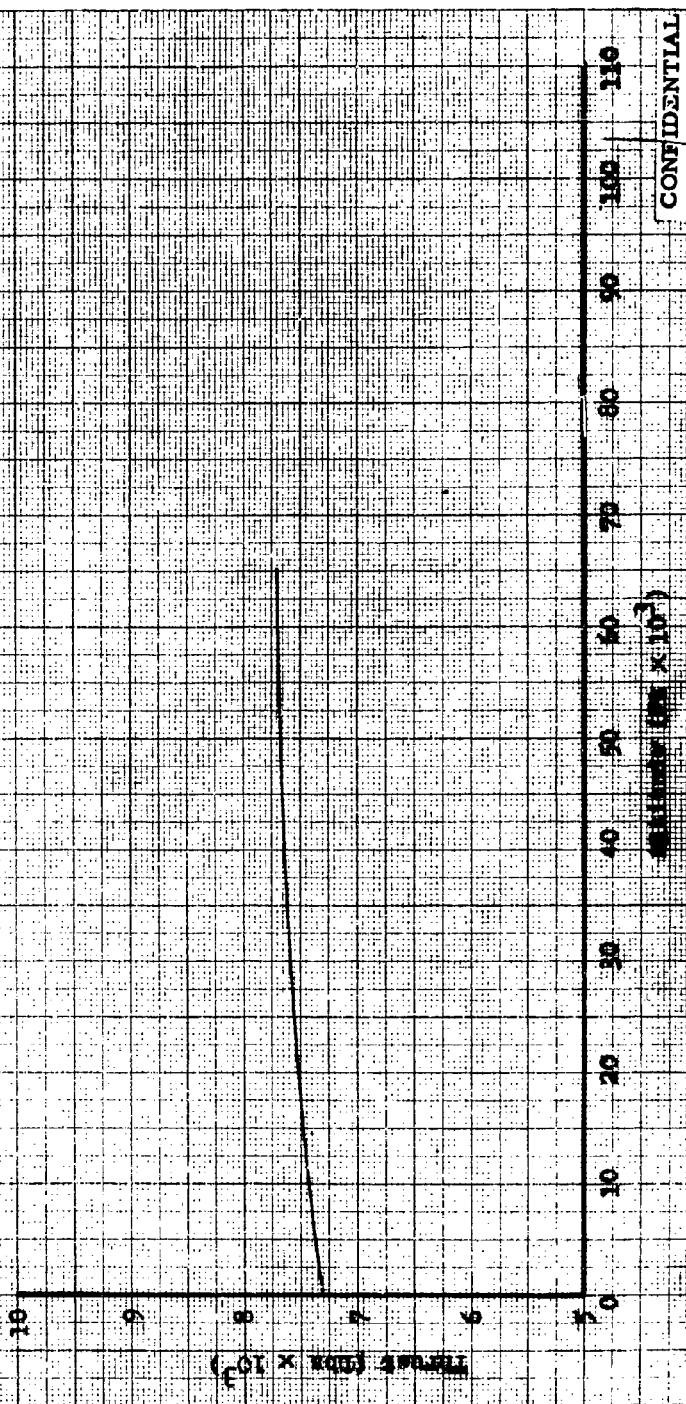
+150°F = 14,448 lbs/sec



CONFIDENTIAL

CONFIDENTIAL

Fig. 69 - Example III - Change of Thrust with Altitude



CONFIDENTIAL

Engine Grain 60" F
C-2 and C-3 Motors

Note:

Take this case the form
 $P_{alt} = P_{sea} + \frac{\rho}{2} (V^2 - P_{alt})$

Therefore, optimum expansion
is assumed throughout the
Range

**Naval Research Laboratory
Technical Library
Research Reports Section**

DATE: February 26, 2001
FROM: Mary Templeman, Code 5227
TO: Code 5300 Paul Hughes
CC: Tina Smallwood, Code 1221.1 *to 3/8/01*
SUBJ: Review of NRL Reports

Dear Sir/Madam:

1. Please review NRL Report MR-754 Volumes I, II, III, IV, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, MR-1372 and MR-1289 for:

- ☒ Possible Distribution Statement
☐ Possible Change in Classification

Thank you,

Mary Templeman

Mary Templeman
(202)767-3425
maryt@library.nrl.navy.mil

The subject report can be:

- ☒ Changed to Distribution A (Unlimited)
☐ Changed to Classification _____
☐ Other:

Ben H. Cantrell
Signature

3-8-01
Date

**** MAY CONTAIN EXPORT CONTROL DATA ****

Record List

**03/8/101
Page 1**

AN (1) AD- 368 416/XAG
FG (2) 010100
010303
160201
160401
CI (3) (U)
CA (5) NAVAL RESEARCH LAB WASHINGTON D C
TI (6) SUMMARY OF NAVY STUDY PROGRAM FOR F4H-1 WEAPON SYSTEM. APPENDIX TO VOLUME XI
AU (10) Ryon ,J. C.
Loughmiller ,C. M.
Lister ,R. L.
Bellavin ,I. N.
Schmookler,M.
RD (11) Aug 1960
PG (12) 75 Pages
RS (14) NRL-MR-754-Vol-11-App
RC (20) Unclassified report
NO (21) See also Rept. no. NRL-MR-754-Vol-11, AD-368 355.
AL (22) Distribution: DoD only: others to Director, Naval Research Lab., Washington,
D. C.
DE (23) (*JET FIGHTERS, NAVAL RESEARCH)
RANGE(DISTANCE), ERRORS, DRAG, AERODYNAMIC LOADING, PITCH(MOTION), MOMENTS,
ROLL, AEROELASTICITY, ALTITUDE, THRUST (U) AIR TO AIR MISSILES, RADAR HOMING,
LAUNCHING, NOISE(RADAR), GUIDANCE, GUIDED MISSILE TRAJECTORIES
DC (24) (U)
ID (25) AN/APA-128, F-4 AIRCRAFT, SPARROW
IC (25) (U)
DL (33) 04
CC (35) 251950

**APPROVED FOR PUBLIC
RELEASE - DISTRIBUTION
UNLIMITED**